INTERNATIONAL COMMODITY PRICE SHOCKS AND NIGERIAN HOUSEHOLDS, 2006 - 2011

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ABSTRACT

Nigeria's dependence on food and refined oil importations makes households vulnerable to price shocks of these commodities. While there is a growing body of empirical literature on the consequence of international commodity price shocks, there is little attempt to investigate their effects on households. This study, therefore, examined the effects of international price shocks to food and refined oil on household income and consumption in Nigeria.

A recursive-dynamic computable general equilibrium model, based on the Walrasian theory of market behaviour, was employed. The model was able to analyse the income and consumption effects of food and refined oil price shocks on households as it captured changes in the relative prices of product and factor goods. The model had production, income and savings, demand, international trade, prices, equilibrium, and dynamic blocks. It was calibrated using a modified 2006 Nigeria Social Accounting Matrix (SAM). In the SAM, households were categorised into rural poor (RP), rural non-poor (RNP), urban poor (UP) and urban non-poor (UNP). Capital stocks were considered using investment, while labour supply and the minimum consumption of households were adjusted each period by population growth rate in order to capture the dynamic adjustment path of households to food and refined oil price shocks over a five-year (2006 - 2011) horizon. Diagnostic tests (baseline simulation test and Leon) and sensitivity analyses were carried out to ascertain the model's consistency as well as the robustness of the simulation outcomes.

A 37.0% positive shock in the international food prices increased incomes of RP, RNP, UP and UNP households by 2.4%, 2.9%, 1.9% and 1.5%, respectively, as domestic supply response increased all categories of household labour income by 2.1%, and RP and UP households' capital income by 3.5%. Consumption declined by 1.4%, 0.8% and 0.2% for RP, UP and UNP households, respectively, partly because the domestic prices of major products consumed by these households rose between 0.55% and 6.48%. However, as RNP household income increased by 2.9%, consumption rose by 0.61%. In contrast, a positive shock in the international price of refined oil by 60.0% reduced RP, RNP, UP and UNP households income by 6.1%, 5.5%, 5.6% and 4.3%, respectively, due to weak domestic supply response engendered by the small labour absorption (less than 0.1%) in the refined oil sector and low oil-refining capacity. Also, consumption of RP, RNP, UP and UNP households correspondingly declined by 2.5%, 2.6%, 2.7% and 2% owing to declines in household incomes and increase in the domestic prices of some commodities by 13.3%, on average. These results were partly due to the large share of imported refined oil and the relative substantial domestic production of food.

Positive shocks to the international price of refined oil adversely affected households' income and consumption in Nigeria between 2006 - 2011. Similar shocks to international food prices increased household income but adversely affected consumption. Increased domestic production of food and refined oil may reduce the negative effects of international price shocks to these commodities.

Keywords: Commodity price shocks, Social accounting matrix, Household consumption, Computable General Equilibrium Model

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DEDICATION

This work is dedicated to:

Abba Father for his endearing love to me;

His Son, Jesus Christ for his grace and mercy; and

His Holy Spirit, for his patience, continual guidance, and help through life's journey.

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CERTIFICATION

We, the undersigned, hereby certify that this work was carried out by Samuel Chinedu OMENKA under our supervision in the Department of Economics, Faculty of the Social Science, University of Ibadan, Nigeria.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The consequences of international commodity price shocks on developing economies have been a matter of grave concern for academics, researchers, and policymakers since many of these economies depend heavily on primary commodities for the bulk of their export earnings. This interest is further fuelled by the rising tide of globalisation and financial integration which have exposed more households to significant risks and potentially large economic and social costs.[1]

Thus, a large body of literature has been devoted to understanding how international commodity price shocks affect households through their impacts on output, growth and distribution (see World Bank, 2010; Mendoza, 2009; Agenor, 2005a; Essama-Nssah, 2005; Ames *et al.*, 2001; Seventer, 2001). One of the reasons for this is the growing recognition that unfavourable shocks affect some households the more than others because they often lack the means to protect themselves, and therefore they were often forced to engage in risk avoidance strategies in order to reduce their vulnerability to the shocks. This, however, may entail large loss in their welfare (Agenor, 2005a).

Mallick (2008) notes that the effects of shocks can be temporary if households have assets to sell or access to credit, otherwise these households can eventually be pushed below the poverty line. This is usually the case for most households in developing countries because they have weaker "shock absorbers" as they lack assets or access to well-functioning credit markets. Also, the extent of transmission of shocks to households depends crucially on the nature of the shock (temporary or permanent), the economy's macroeconomic strengths and vulnerabilities (the degree of international integration via trade or financial flows), the initial household condition and

[1] See, Goldberg and Pavcnik (2007) on the distributional effects of globalization, and Prasad *et al.*, (2003) for some empirical evidence of financial globalization on developing countries. In fact, with the global economy entering "a new dangerous phase" predicated by the Euro zone crisis coupled with disruption in global prices of all sorts and crude oil in particular, there has recently been a resurgence of interest in this area of international macroeconomics.

characteristics, and the extent and types of policy responses by the government (Mendoza, 2009). For instance, the recent commodity price changes (in particular, oil and food prices), which have involved a reversal of much of the commodity price boom of 2007 and 2008 has and is likely to have profound effects across households in developing countries since not all households are in a position to smooth consumption intertemporally.

The presence of credit constraints disallows some households to smooth consumption and weakens their ability to make valuable investments for the future. Thus, some households can be more affected by shocks than others. Households are affected, first, as consumers by changes in prices and availability of consumer goods; as suppliers of factors of production (particularly labour); and lastly as producers in the agricultural and non-agricultural sectors.

1.2 The problem

Developing countries are particularly vulnerable to international commodity price shocks (see Cashin *et al.*, 1999). Many of these countries are primary commodity exporters,[2] or net oil or food importers, hence, they are susceptible to volatility in the international prices of these commodities. Shocks to the international price of traded primary commodities lead to changes in a number of flow-of-fund variables that determine macroeconomic equilibrium (Essama-Nssah, 2005). In Nigeria, due to its dependence on earnings from crude oil exports, the decline in oil prices by mid 1981 led to the decline in foreign exchange reserve from $25 billion in 1980 to $7.2 billion in 1986 and a subsequent fall in the balance of payment from a surplus of ₦2.4 billion in 1980 to a deficit of ₦7.84 million in 1986. A bid to maintain the fixed exchange rate system led to the fall of the reserve by more than ₦4 billion between 1980 and 1983 (CBN, 1990; CBN, 1985). As a result, the country resorted to external borrowing. With soaring interest rates, the floating rates on Nigeria's loan (like other developing countries) also shot up. Higher foreign interest payments taxed the domestic economy more by channelling vital resources away from the productive sectors, and consequently, the welfare of the people declined.

[2] For instance, primary commodities accounted for 73 percent of total exports of African countries during the period 1985-2000 (Raddatz, 2008).

The decline in the welfare of Nigerians – an indication of declining real income and consumption is evidenced by the poverty incidence[3] of the country which shows that the population in poverty has increased significantly since the 1980s. By 1985, poverty had become a national issue as urban poverty incidence more than doubled, rising sharply from about 17% in 1980 to about 38% in 1985. The incidence of rural poverty equally increased remarkably from about 28% to about 51% during the period (see National Bureau of Statistics - NBS, 2005; UNDP, 2009; Anyanwu, 2010). It was estimated that the total population in poverty had increased to about 71.5% in 2011 from about 27.2% in 1980 (NBS, 2012).

There are possibilities that this precarious situation was aggravated by the food insecurity issues plaguing the majority of Nigerian households. This is due, among other factors, to the country dependence on food imports as well as the dramatic increases in food prices which began in 2006 and peaked in July 2008. During this period the real prices of food traded in the world markets rose by an average of about 80 per cent (Adam and Ajakaiye, 2011). This surge in the prices of food (especially, staple foods like rice) was transmitted into the country. For instance, the price of 50kg bag of the premium brand of imported rice (caprice gold) which was about ₦7,500 in December 2007 rose to ₦14,000 by March 2008, representing an 87% price increase. Also, the prices of palm oil, maize, guinea corn, beans and garri rose by 36, 28, 16, 12, and 8%, respectively, over the same period (CBN, 2008).

A case in point as regards Nigeria's dependence on food imports is its import-demand for rice. It is estimated that Nigeria requires about 2.5 million metric tonnes of rice annually while local rice production is less than half a million metric tonnes per year, thus, it is short of two million tonnes of rice, which it sources from other countries (Ojo and Adebayo, 2012). Consequently, with reliance on food import as well as rising international prices of food, a huge amount of fund is spent as food import bill in Nigeria. For instance, the total food import bill which stood at ₦89.9 million in 1961-1970 period rose phenomenally to ₦3.3 billion during 1981-1990, ₦62.7 billion in 1991-2000 and ₦170.2 billion in 2001-2006 (Anyanwu *et al.*, 2011).

[3] In the National Bureau of Statistics, the process of defining poverty incidence starts with the estimation of the poverty line. The poverty line refers to the expenditure level below which households cannot attain sufficient calories (basic energy requirement) - even if they spend all their money on food. This is a money-metric measurement of poverty (that is, the lack of income or consumption). It is, however, acknowledged that poverty measurement goes beyond monetary definitions.

Thus, there are strong reasons to believe that food availability is not the only challenge of many households in Nigeria but its affordability. This has generated some coping strategies including buying prepared food from food vendors, eating fewer meals or skipping meals, and purchasing particular foods based on affordability rather than preference (Ogunyankin and Omenka, 2012).[4] A major implication of these coping strategies is low food-energy intake. This pushes them below the predetermined food energy requirements, and hence, poverty threshold.

It has been argued that government's policy responses to external shocks such as those to food and oil have also significantly affected Nigerian households (see Loayza *et al.*, 2007; Tomori *et al.*, 2005; Ajakaiye and Adeyeye, 2004; Olaniyan, 2000). For instance, policy responses such as external borrowing to help temper the impact of adverse oil price shocks or tariff reduction on food imports may be advantageous in the short run but can, in the long run, exert more pressure on countries' public finances due to increasing interest payments on debt[5] or higher taxes on households. In addition, mounting fuel subsidy cost which cushions the domestic economy from increase in the international price of petroleum has severely reduced government's ability to fund programmes which are oriented to the improvement of lives of the population, and thus, informed considerations towards the removal of fuel subsidy. This policy-shift generated tensions in both the fiscal sector and social environment. There is, however, the question of whether or not the removal of fuel subsidy has macroeconomic benefits and whether it improves households' welfare given the country's vulnerability to international commodity price shocks (particularly, oil price shocks).

These concerns raise the following fundamental questions: What are the implications of food price shocks and oil price shocks on the Nigerian households? How are these shocks transmitted to households in Nigeria? Which household is more affected: poor or non-poor households? Finally, what are the effects of government policy responses on households' experiences to these shocks?

[4] These coping strategies are peculiar to women (especially, female head of households). Skoufias and Zaman (2010) also find that both poor and vulnerable non-poor switch away from nutrient rich foods and to lower calorie intake.
[5] It is plausible to acknowledge that the debt problem was partially caused while Nigeria was adjusting to externally-induced shocks (particularly, the decline in oil price in the early 80s).

1.3 Objectives of the study

The primary objective of this study is to analyse the effects of international commodity price shocks on households in Nigeria. In particular, it seeks to:

(i) analyse the effects of refined oil price shocks and food price shocks on households in Nigeria;

(ii) identify the channels through which these shocks are transmitted to the Nigerian household; and

(iii) examine the effects of fiscal policy in mitigating the impacts of shocks on households in Nigeria.

1.4 Justification for the study

Most studies on commodity price shocks (particularly, oil price shocks) in Nigeria did not consider their effects on households. For instance, most of the studies focused on the effects of oil price shocks on macroeconomic activities in Nigeria (see Olomola and Adejumo, 2006; Olusegun, 2008; Aliyu, 2009; Umar and Abdulhakeem, 2010; Iwayemi and Fowowe, 2011; Aye, 2012[6]). This could be because, until recently, little is known about how oil price shocks are transmitted to households or because it was beyond the objectives of the studies. Although some other country studies have tried to capture the transmission channel of price shocks, however, there are still considerable debates on key transmission channels. A few studies emphasize the role labour market (Agenor, 1996; Agenor, 2005b), others accentuate inflation, exchange rate channel and the supply side effects (McDonald and van Schoor, 2005; Headey and Fan, 2008; Agenor, 2005a). Thus, analysing the effects as well as identifying the key channels via which commodity price shocks (particularly, oil and food) exert influence on households in Nigeria is imperative especially if policies geared toward mitigating the impact of adverse shocks must be pro-poor.

Three notable studies, Tomori *et al.*, (2005), Ajakaiye and Fakiyesi (2009), and Nkang *et al.*, (2013) which tried to capture the households' effects of these types of shocks in Nigeria employed different methods.[7] While the two latter studies used a static computable general equilibrium (CGE) model, the former employed error correction

[6] Unlike the other studies, Aye (2012) focused on the long- and short-run impacts of food and energy price shocks on the Nigerian economy.

[7] These studies did not also ascertain the key channels of transmission of the primary shocks investigated.

model (ECM) and questionnaire survey method. An obvious shortcoming of the ECM is that "…we are unable to link the partial correlation coefficients to any particular theoretical structure of the Nigerian economy. Thus, there is no strong theoretical basis (flowing directly from the model results) for making strong inferential policy statements about the implications of the identified variables for ameliorating macroeconomic policy shocks" (Tomori *et al.*, 2005, 45).

The CGE models employed by Ajakaiye and Fakiyesi (2009) and Nkang *et al.*, (2013) successfully capture the effects of oil price shock, and food price shock, respectively, on households while being consistent with economic theory and the structural characteristics of the country. However, the models - static in nature, do not allow for recursive effects within the macro connections and between the macro and household connections. The implication is that their analyses do not provide answers to changing conditions of economic agents. This shortcoming is also applicable to studies like Devarajan and Go (2003) for Zambia, Daza *et al.*, (2004) for Bolivia, and Descamps *et al.*, (2005) for Venezuela which bear some resemblance with the current study based on the commodity price shocks studied.[8] This study accounts for this shortcoming by employing a dynamic CGE model - an attractive point of departure from the static model. It should be noted, however, that the CGE model employed in this study is a recursive-dynamic, characterized by a sequence of temporary equilibria. Unlike truly dynamic CGE models, recursive-dynamic CGE models assume that economic agents are myopic.[9] This is consistent with the context of developing countries where imperfect information exists (see Chitiga and Adenikinju, 2009). Thus, it has the unique advantage of capturing the time path of adjustment to shocks in a recursive sense.

Another significant deviation of the current study from Ajakaiye and Fakiyesi (2009), and Nkang *et al.*, (2013) is its analyses of combined oil and food price shocks effects' on households in Nigeria. While the former study focused on shocks to the international price of crude oil, the latter considered only food price shock. But given the recent-past experience of Nigeria (as in other national economies) with respect to

[8] Descamps *et al.*, (2005), considered oil price shocks and fiscal shock, Daza *et al.*, (2004) considered terms of trade shock and reduction in foreign savings, while Devarajan and Go (2003), focused on shocks in copper prices and public expenditure.
[9] Truly dynamic CGE models assume economic agents have perfect foresight, and have been applied in early empirical works such as Goulder and Summers, 1989; Jorgenson and Wilcoxen, 1990; Jorgenson and Yun, 1990.

shocks to oil and food prices, analysing only one of these shocks underestimates the effects of the shocks on the economy, and households (in particular). Thus, the results generated from the current study better reflects the experience of the country in recent past.

The final key innovation in this study is two-fold: (i) it explicitly accounts for petroleum subsidy in the Nigeria's Social Accounting Matrix (SAM) and CGE framework, thus, making it possible to model more precisely the oil sector and the effects of oil shocks on households, especially in the case of a complete or partial removal of subsidy; (ii) unlike Nkang *et al.*, (2013), it uses a measure of food price shocks that is based on actual changes in prices of selected major staples in Nigeria. This way it minimizes the possibility of overstating the effects of food shocks since not all food prices increased by the same magnitude.

1.5 Scope of the study

The model includes some dynamic features simulated over a five-period horizon with a base year of 2006. The study is, thus, an ex-ante analysis. The choice of the 2006 base year is because of the availability of a 2006 Nigeria Social Accounting Matrix (SAM), and the need to capture the period marking the beginning of the recent episode of oil price surge and to make comparison with rises in major staple foods prices. The 2006 Nigeria SAM is appropriate for this study given that it is the latest and there has been no significant change in the structure of the Nigeria economy. The horizon is set at five years so as to capture the effects of policy responses which are not usually immediate.

This study focused on the implications of oil price shocks and food price shocks as well as the effects of alternative government policy response on households in Nigeria for three reasons. First, oil price changes represent the main commodity price shock experienced by the country due to its dependence on revenue generated from crude oil export, and the role of refined oil as an intermediate input in the production of goods consumed by households. Second, food expenditure represents a major component of most households' budget since many of the households are poor (see 2004 Nigerian Living Standard Survey)[10]. Third, from the policy point of view, these shocks create a number of economic problems which cause greater difficulties for many households (especially, poor households) who are less able to protect themselves against adverse

[10] See also, Appendix A

shocks. Thus, this study proves useful in understanding the effects of international commodity price shocks on Nigerian households as well as the trade-offs of certain policy interventions. It also enhances knowledge on the factors that should drive policy responses as different outcomes can be expected even within a country.

1.6 Plan of the study

This study is organised under seven chapters structured as described below. Following this chapter is Chapter Two which is divided into two broad parts. The first part presents a definition of key concepts as used in this study with the aim of clarifying any conceptual ambiguities. The second part provides a detailed background to the study comprising macroeconomic and structural context issues, a historical perspective of key sectors, poverty incidences and government policies adopted to address these issues in Nigeria. It also includes information on households in Nigeria. The review of literature vis-à-vis theoretical, empirical and methodological literature is well documented in the third chapter. The main focus of the survey is to highlight how empirical findings in the household effects of international commodity price shocks are largely driven by methodological approaches as well as theoretical underpinnings. A conceptual framework and theoretical structure of the model are presented in the Chapter Four. The bench-mark data and research methodology are presented in Chapter Five. The model focuses on the real side of the economy. A description of the simulation scenarios is also discussed in chapter five. Chapter Six presents and discusses the simulation results generated from the analyses carried out using the CGE model. Chapter Seven is made up of a summary of findings, policy implications, limitations of the study, and concluding remarks.

CHAPTER 2

COMMODITY PRICE SHOCKS, NIGERIA'S ECONOMY AND HOUSEHOLDS

2.1 Introduction

This chapter is broadly divided into two parts. The first part provides a conceptual meaning of shocks, its types and sources, as well as identified causes of international commodity price shocks, while the second part provides background information on the Nigerian economy with respect to the study's context. Specifically, following this introduction, the concept of shocks and its types, and causes are presented in Sections 2.2 and 2.3 respectively. Section 2.4 gives an overview of the Nigerian economy vis-à-vis the key sectors of the economy and government policies. The characteristics of households, trends in income distribution, and poverty in Nigeria are discussed in Section 2.5. The last section, Section 2.6, concludes the chapter. This chapter therefore, provides a background story that clearly aids the understanding of how and why international commodity price shocks permeate the Nigerian economy and households. It also aids the modelling exercise.

2.2 The concept of shocks

Shock is a term used widely in modern economics. Although its history in macroeconomics can be traced from Frisch and Slutzky in the 1920s and 1930s, its use in the vocabulary of economists can be dated only to the early 1970s. Since then shocks has become a central element in observing macroeconomic phenomena (Duarte and Hoover, 2011). In their study "Observing Shocks", Duarte and Hoover noted that early economists have used the term "shock" in a variety of ways, including: "an unending succession of slight shocks of earthquake to the terrestrial structure of business, varying of course in practical effect in different places and times…" (in Horton, 1886, 47); "…disturbances of production, and fluctuations of prices" (in Francis Walker 1887, 279) which, primarily among the working class, is a cause of suffering; and, those disturbances[11] that "takes the form of a discontinuous (or nearly discontinuous) change in initial conditions…" (in Frisch 1936, 102).

In addition, they observed that during the era of the New Classical Macroeconomics, shocks was used in the sense of: a dramatic exogenous event (for example, calling the substantial increases in oil prices in 1973 and 1980, "oil shocks"); an irregular but permanent changes to underlying structure (for example, supply shocks or demand shocks); a one-time shift in an exogenous variable; and, a generic synonym for any exogenous influence on the economy. Accordingly, these usages continue to the present day where shocks have come to be considered as the objects of economic analysis. For instance, Ho and Hoon (1995) analysed the effects of shocks such as an exogenous decline in private savings, expansionary debt financed fiscal policy on the real interest rate; Fielding and Shields (2001) considered shocks to identify impacts on output and prices; while Ferreira *et al.*, (2004) examined if the distributional impacts of shocks can be predicted. Campos-Vazques (2010) considered shocks from the perspective of economic crisis.

Although, shocks have been used in a variety of ways in economics literature, it generally underscores a notion of unexpected disturbances that have significant impact on the economic system. Thus, for the purpose of this study shocks is defined as those exogenous disturbances that affect: (i) aggregate or macroeconomic variables (e,g gross domestic product (GDP), total investment, volume of exports and imports, exchange rate); and (ii) a large group of people within a country.[12]

Following from this contextual definition of shocks, different types of economic shocks can be identified. They include, among others: shocks related to financial and economic crisis like the Mexican Peso crisis, the Asian financial crisis, and the 2007-2008 Global Financial crisis (see, Whitt, 1996; Benk *et al.*, 2005; Sawada *et al.*, 2007; Jermann and Quadrini, 2009); price shocks such as those of internationally tradable goods like crude oil, minerals and food grains (see for instance, Valadkhani and Mitchell, 2002; Kpador, 2006; Kilian, 2009; Gubler and Hertweck, 2011); and, policy shocks (see for instance, Christiano *et al.*, 1999; and Mountford and Uhlig, 2009).

[11] Frisch (1936) described disturbance as any new element which was not contained in the determinate theory as originally conceived.

[12] This definition, drawn from Mendoza (2009), allows for a broader consideration of literature on different types of shocks.

Three sources of shock can be identified in the literature. They include nature, the market, and government (see Lacobucci *et al.*, 2001). The first source can be classed under external source while the latter two can be classed under internal sources. Natural disasters such as hurricane, floods, droughts, and earthquakes belong to the category of natural shocks. In the category of internal sources, shifts in supply and demand in domestic and international markets can lead to changes in commodity prices. Also, a change in government policy can also create shocks. While some shocks have positive effects on an economy, the term is largely used for events that impact an economy negatively (sometimes with devastating consequences).

2.3 Causes of commodity price shocks

Given this study's focus on shocks related to the price of international tradable goods, this section centres on the causes of commodity price shocks. The causes of commodity price shocks are complex due to a combination of mutually reinforcing factors. While some of the factors (which still remain contested) are transitory, others are more permanent. The causes of commodity price shocks can broadly be categorized into demand-side and supply-side factors. These are discussed in turn below.

(i) Structural and demand-side factors

Strong global economic growth and rising population are principal demand-side factors that cause international commodity price shocks (Hamilton, 2008; World Bank, 2011). With accelerated world economic growth and increase in population there is increase in consumption. The Economic and Social Survey of Asia and the Pacific (2009) noted that there is a positive association between economic growth and growth in petroleum consumption; however, because production has often lagged behind, there is usually a case of excess demand with implication on prices. This was the case between 1998 and 2006 when global petroleum consumption increased at an average annual rate of 1.7% while world petroleum production grew at an annual average growth rate of only 1.4%.

This thought-line of linking oil shocks to exogenous shortfalls in crude oil production has been *weakly* contested. It has been argued that all major real oil price shocks since the mid-1970s can be traced to increased global aggregate demand and/or increases in oil-specific demand, with the latter demand shifts being consistent with sharp increases in precautionary demand in the wake of political events in the Middle East. These political events, however, led to the stagnation of supplies from the Organization of the Petroleum Exporting Countries (OPEC) and decline in production in non-OPEC economies. An important structural demand factor is the competing use of food grain to produce ethanol as a substitute for oil – the oil-biofuels nexus. Abbott and de Battisti (2011) note that competition for grains and oilseeds as food versus fuel are major causes of rising food prices. In fact, data from the Food and Agricultural Organisation (FAO) shows that biofuels demand accounted for 60% of the global change in demand for wheat and coarse grains between 2005 and 2007, with around 90% of that biofuels demand coming from the U.S. market.

(ii) Supply-side factors

On the supply side, urbanization, competing demand for land for commercial or other uses as opposed to agricultural purposes, climate variability and disruptive weather patterns are important factors that cause commodity price shocks. Climate variability describes seasonal changes, inter-annual variability and the likely frequency of weather-related extreme events. Droughts, rainfall and temperature volatility are potential channels through which climatic variability can create shocks. While cropping patterns away from food to biofuels may reduce the available supply of land devoted to food (ADB, 2008a), the effects of climate change are also likely to adversely impact agricultural output and cause supply disruptions (ADB, 2008b). Irregular and adverse changes in climatic conditions especially with regards to the supply of rainfall puts more stress on water resources for agricultural purposes, changing water flows and its availability (Flammini, 2008). Given the possibilities of supply shortages relative to demand, a price shock may result since price is the main instrument available to equilibrate the market in the short term.

Besides extreme rainfall variability such as droughts and floods, other disruptive weather patterns have been noted to cause *disturbance* to production, income generation and prices. Examples include the devastating hurricane Mitch in Honduras, the earthquake that struck the Japanese port city of Kobe in the early morning of January 17, 1995, the December 2004 tsunami disaster in the Indian Ocean, the Pakistani Kashmir earthquake of October 2005 and the September 2005 inundation of New Orleans following hurricane Katrina (see, Horwich, 2000; Narayan 2001; Selcuk and Yeldan, 2001; Benson and Clay, 2004; Banuri 2005; and Cavallo and Noy, 2010).

2.4 Nigeria's macroeconomic and structural context issues

Nigeria is the single largest geographical unit in West Africa. It occupies a land area of 923,768 square kilometres situated between longitude 3^0 and 15^0 East, and latitude 4^0 and 14^0 North. It is estimated that one in every six black people in the world is a Nigerian. The country has more than 200 ethnic groups, with three major tribes, the Igbo (East), the Hausa (North), and the Yoruba (West) (CBN, 2000).

The Nigerian economy is broadly structured into five activity-sectors: agriculture, industry, building and construction, wholesale and retail trade, and services. Prior to the advent of commercial oil exploration in the early 1970s in Nigeria, agriculture was the dominant economic activity in terms of employment and linkages with the rest of the economy. It supported about 75% of the population, supplied the people with 94% of their food, and provided 68% of GDP and 78% of exports. It was also the principal foreign exchange earner of the country (see World Bank, 1996). In fact, Nigeria was once the world's largest exporter of groundnuts, cocoa, and palm oil. However, due to a number of factors including the growing burden of taxation, agriculture began to stagnate.

Rapidly growing industries exerted considerable influence on the economy which led to a shift in the pattern of industrialisation from the processing of agricultural products for export towards simple import substitution as well as the emergence of petroleum extraction as a leading growth sector. This led to the transformation of the Nigerian economy from an agrarian economy to an oil-based economy in the early 1970s. Since then the agricultural sector has been a grey area in the Nigerian economy. In fact, the percentage contribution of agriculture in total export declined continuously from about 89.7% in 1960 to about 2.2% in 1985. Thereafter, it increased marginally to about 4.1% in 2005. In contrast, the oil and mining sector dominated Nigeria's exports since 1970, rising sharply from about 7.8% in 1960 to 93.6% in 1975 and then steadily onwards (CBN, 2005). However, as Table 2.1 shows, over this period the contribution of crude petroleum to GDP remained lower than that of agriculture.

In the early 1970s the budget buoyed by the growing oil revenues but this was after a sharp decline in foreign exchange earnings and government revenues attributed to the ensuing civil war in the late 1960s which led to the loss of all on-shore production of oil. The speed of the recovery was entirely due to all expansion and rapid growth of government spending due to the positive oil shocks of 1973 and 1979 which increased the terms of trade more than four times between 1972-80 (see CBN, 2007). However, the sharp decline in petroleum output and fall in world oil prices in the early 1980s brought to the forefront the precarious nature of the country's economic and financial position, including poverty incidences. Since then the Nigerian economy has remained highly vulnerable to fluctuations in oil prices.[13]

This section, therefore, provides an overview of key macroeconomic and structural context issues germane to understanding the main features of the Nigerian economy necessitating the permeation of international commodity price shocks to households as well as the linkages across the economy.

[13] In fact, Nigeria's economy ranked among the most volatile in the world for the period 1960 to 2000 (see, World Bank, 2003).

Table 2.1. Structure of the real GDP by sectors (in %), 1961-2010

Activity Sector	Agriculture	Industry	Building & Construction	Wholesale & Retail	Services	TOTAL (GDP)
1961-65	59.71	8.80	4.55	12.86	14.09	100.00
1966-70	49.46	15.52	5.15	12.72	17.15	100.00
1971-75	29.22	27.64	7.97	18.10	17.06	100.00
1976-80	22.12	32.76	9.42	20.24	15.46	100.00
1981-85	30.57	41.76	2.98	14.57	10.11	100.00
1986-90	33.81	40.46	1.71	14.42	9.61	100.00
1991-95	33.36	39.61	1.79	14.10	11.14	100.00
1996-00	35.27	37.58	1.90	13.37	11.87	100.00
2001-05	40.88	30.44	1.66	12.16	14.86	100.00
2006-10	41.68	22.35	1.83	17.20	16.93	100.00
Average 1961-2010	*37.48*	*32.09*	*2.03*	*14.71*	*13.68*	*100.00*

Source: Computed by Author; based on data from Central Bank of Nigeria (CBN) Statistical Bulletin, 2010

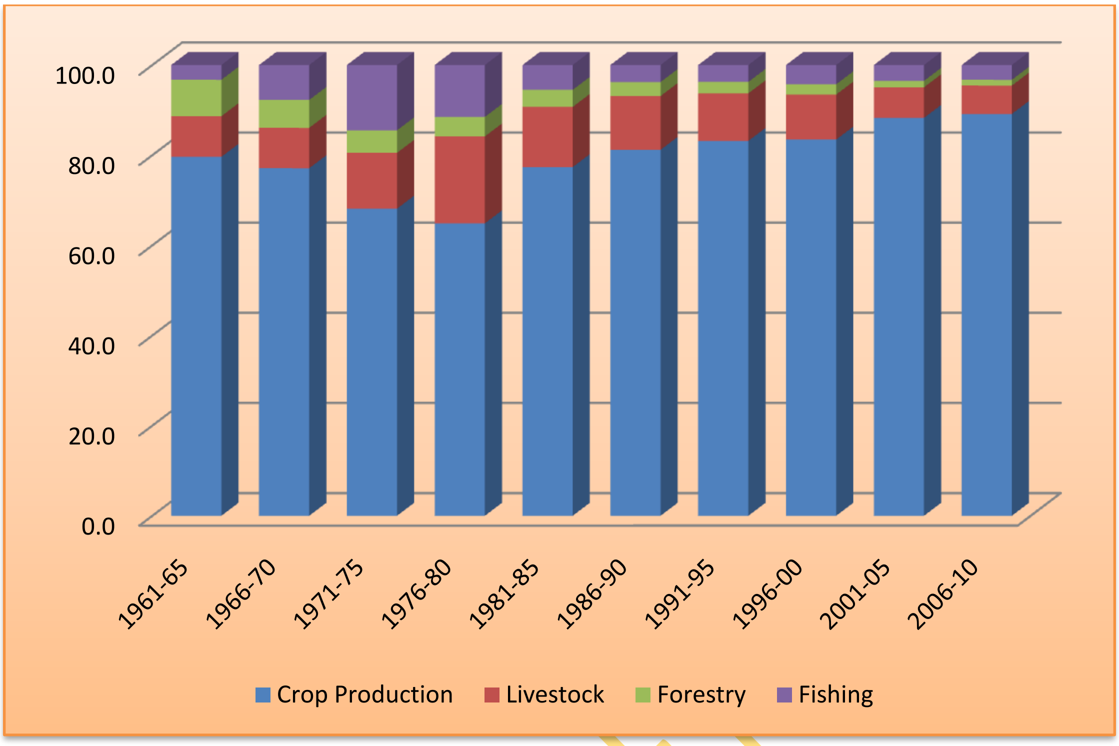
2.4.1 Agricultural sub-sectors and their performance

Nigeria's agricultural economy is generally divided into four sub-sectors namely crops, livestock, forestry and fisheries. The crops sub-sector has been, and remains, the dominant component of Nigerian agriculture - contributing over 60% of the agricultural GDP since 1960s as shown in the Figure 2.1. In recent years, between 2000 and 2010, its contribution to agricultural GDP averaged about 88% while other components - livestock, forestry and fisheries make up just about 12% of agriculture GDP. The share of forestry (about 1.5%) remains the least over the period. Table 2.2a and 2.2b reveals no significant structural changes in the composition of the different agricultural sub-sectors and their contribution to GDP since the year 2000. Given the large size of the crops sub-sector relative to the other three, growth performance in the crops sub-sector drives overall growth performance in agriculture.

The crop sub-sector is often divided into either of two categories (i) staples and other crops, or (ii) cereals, pulses, oil seeds, roots and tubers, and fruits and vegetables. Among Nigeria's food staples, cereals account for the largest share of cultivated areas while roots and tubers account for the largest share of production due to higher yields per unit land area. The relative contribution of individual crops to agricultural GDP gives an indication of the economic importance of the various crops and their potential for value adding to the national economy.[14]

In recent years, staple foods showed superior growth rate relative to the "other crops" group. Table 2.3 shows that while staples recorded an average growth rate of about 7% between 2005 and 2009, the corresponding figure for "other crops" was about 6%. The Table 2.3 reveals that growth rates recorded in the crop sub-sector are higher than those of other sub-sectors. For instance, livestock and fishing recorded average growth rates of 5.8% and 5.54% respectively. The provisional estimated growth rates for 2010 were 6.45% and 6.97% for livestock and fishing respectively. According to the Report of the National Technical Working Group on Agriculture and Food Security (2009) the observed food crop production growth in Nigeria has been driven entirely by expansion in area planted rather than increase in productivity. Despite its performance, Nigeria continues to depend on food import. In fact, the Report stated that Nigeria spends over $3 billion annually on the importation of staple food.

[14] See, Table 1 in Appendix B for the contribution of individual crops to GDP in 2006. The first six crops are referred to as the main staples which have been defined as food in this study.



Source: Author's drawn; underlying data from Central Bank of Nigeria (CBN) Statistical Bulletin, 2010
Note: Bars represents a 5-year annual average.

Figure 2.1. Contribution of agricultural sub-sector to agriculture GDP, 1961-2010

Table 2.2a. Contribution of agriculture sub-sectors to agriculture GDP (2000 - 2010)

Year/ Sector	Crop Production	Livestock	Forestry	Fishing
2000	83.42	9.71	2.17	4.70
2001	83.36	9.63	2.13	4.89
2002	88.77	6.50	1.38	3.35
2003	89.10	6.33	1.31	3.26
2004	89.01	6.34	1.31	3.33
2005	89.08	6.33	1.30	3.30
2006	89.15	6.30	1.28	3.27
2007	89.20	6.28	1.27	3.25
2008	89.16	6.31	1.27	3.26
2009	89.11	6.35	1.27	3.27
2010	89.05	6.40	1.27	3.28
Average 2000-2010	*88.04*	*6.95*	*1.45*	*3.56*

Source: Computed by Author, based on figures from Central Bank of Nigeria (CBN) Statistical Bulletin, 2010

Table 2.2b. Contribution of agriculture and its sub-sectors to GDP (2000 - 2010)

Year/ Sector	Agriculture	Crop Production	Livestock	Forestry	Fishing
2000	*35.83*	29.89	3.48	0.78	1.69
2001	*34.32*	28.61	3.30	0.73	1.68
2002	*43.89*	38.96	2.85	0.61	1.47
2003	*42.60*	37.95	2.70	0.56	1.39
2004	*40.98*	36.48	2.60	0.54	1.37
2005	*41.19*	36.69	2.61	0.53	1.36
2006	*41.72*	37.20	2.63	0.53	1.37
2007	*42.01*	37.48	2.64	0.53	1.37
2008	*42.13*	37.56	2.66	0.53	1.37
2009	*41.70*	37.16	2.65	0.53	1.36
2010	*40.84*	36.37	2.61	0.52	1.34
Average 2000-2010	*40.66*	35.85	2.79	0.58	1.43

Source: Computed by Author, based on figures from Central Bank of Nigeria (CBN) Statistical Bulletin, 2010

Table 2.3. Growth rates of agricultural sub-sectors, 2005-2010, %

	2005	2006	2007	2008	2009	2010	*Average: 2005-2010*
Crop Production	6.65	7.78	6.69	7.27	6.18	5.75	*6.91*
Staples	6.55	7.99	6.75	7.40	6.20	5.72	*6.98*
Other Crops	7.78	5.37	6.04	5.71	5.95	6.10	*6.17*
Livestock Products	5.07	5.99	5.55	5.79	6.76	6.45	*5.83*
Fishing	5.85	4.70	5.75	5.28	6.12	6.97	*5.54*
Forestry ('000 cu.metres)	5.45	1.67	2.67	2.17	5.85	4.85	*3.56*

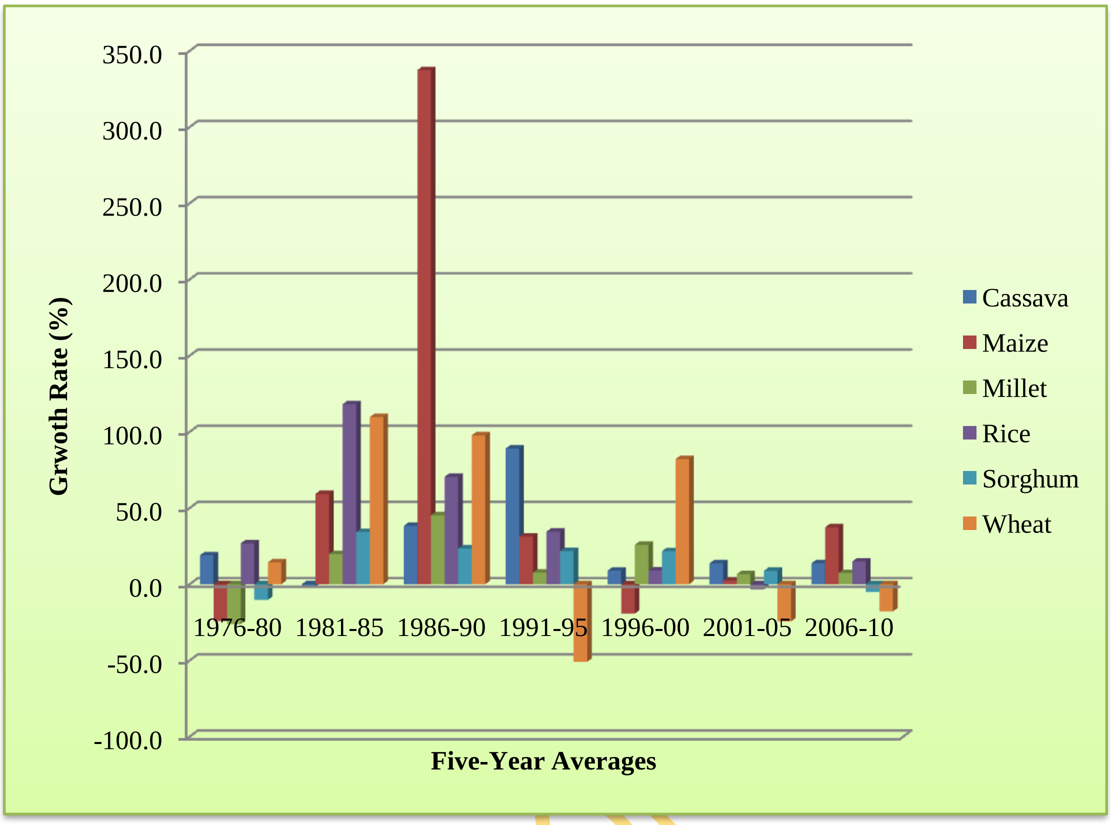
Source: Computed by Author, based on figures from CBN, various Annual Reports and Statement of Accounts

The National Technical Working Group on Agriculture and Food Security Report (2009) also noted that the Nigerian agricultural sector had always played a pivotal role in the nation's food security by providing the largest proportion of the country's total food consumption requirements. In recent times, however, the level of food-sufficiency (especially in cereals) has been falling, resulting in rapid growth in the amounts of cereals imports (rice in particular).

The production of the major agricultural commodities (major staples) generally shows unstable and some negative trends that are inimical to sustainable agricultural growth and development (see Appendix B, Table 2). The trends in agricultural production of various crops and growth performances based on triennial average growth rates presented in Figure 2.2 shows that rice production recorded an increasing growth rate between 1976 and 2000; since then it has oscillated between -21.2% and 31.2%. It is observed that since its peak (of about 118% in the 1981-85 period) rice production has been growing at a decreasing rate.

Maize output recorded exceptionally high growth rate, about 337%, between 1986-1990 period but dismal negative growth rates between 1996-00, 2007, 2009, and 2010 periods. Millet production has been recording positive growth since 1981 though highly variable in nature; negative growth however occurred in 2009 and 2010. Sorghum recorded output growth between 1981 (about 34%) and 2006 (about 8%). The smallest growth in 2008 (about 3%) was followed by the highest negative growth rate in 2009 (about -43%). With the exception of 1981-85, 2007, and 2009, cassava production recorded positive growth rate. Wheat appears to be the most volatile staple since 1991. After recording its highest impressive growth rate of about 110% in the 1981-85 period, it has since then fluctuated between 98% and -38% growth rates.

The observed unstable trends in agricultural commodities production are largely related to supply-side factors including disruptions in rainfall coupled with lack of proper irrigation system, and input policy inconsistency. Eboh *et al.*, (2004) noted that fertilizer procurement and distribution in Nigeria has reflected inconsistencies and instabilities associated with government policy in Nigeria. Also, high cost of production and distribution of seeds, low levels of effective demand for seeds, and delays in the release of budgeted funds to compensate the National Seed Service for subsidies contributed to the observed trend in agricultural production.



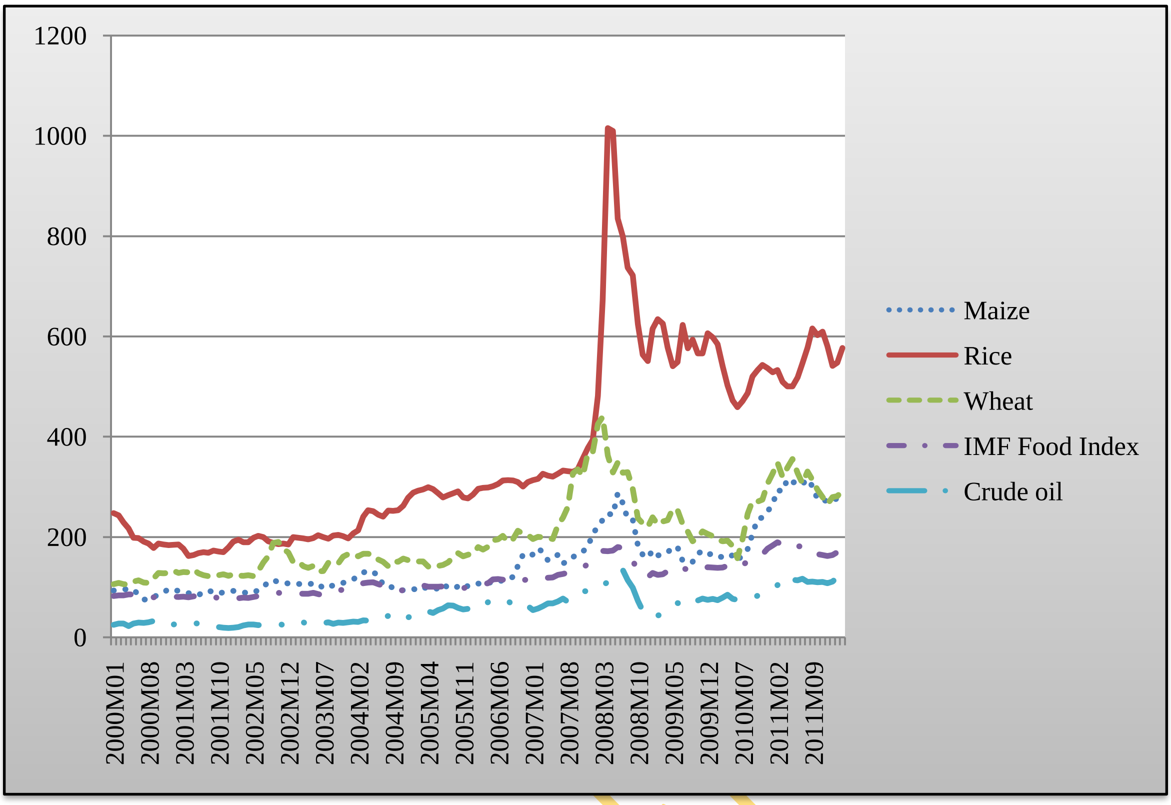
Source: Author's drawn; underlying data from Appendix B, Table 2.

Figure 2.2. Trends in triennial average growth rate of major staple's production in Nigeria (1976-2010)

One of the main issues in Nigeria's agricultural sector is low productivity. The small, traditional farmers who produce over 90% of Nigeria's food still employ simple techniques of production and the bush-fallow system of cultivation, and as a result, productivity is very low. With low productivity and diminishing opportunities for extensive agriculture, the rate of output growth remains low (AfDB, 2005).

This issue is compounded by several other constraints including low mechanization, subsistence small scale holdings, outdated land tenure system, low adoption of research findings and technologies, high cost of farm inputs, poor access to credit, overemphasis on inefficient fertilizer procurement and distribution, inadequate irrigation and storage and poor access to markets (NPC, 2009). Consequently, the incentive to produce more food and agricultural products has weakened considerably, resulting in declining levels of national food self-sufficiency and rising food imports with the likely implication of a loss in the event of higher international food prices.

Much of the concern about the dramatic increases in international commodity prices in recent years —and the more intense price peak during the 1970s—has arisen in a context of intense price spikes such as those in 2007-8 and 2010-11. Although not all agricultural commodities prices increased by the same magnitude - grains and oilseed prices increased the most, with rice being the most expensive at the peak, rising as much as crude oil (see Figure 2.3). In fact, the price of rice in April 2008 was 430% of its 2002 price (Abbott and Battisti, 2011). Figure 2.3 also shows that as at 2012, with the exception of rice, prices for maize and wheat on international markets were approaching the peak levels reached in 2008.



Source: Author's drawn: underlying data from IMF Primary Commodity Price System, 2012
Note: (i) With the exception of Crude oil which is measured in US dollar per barrel, other commodities are measured in US dollar per metric tonne. (ii) 2012 data includes January-September

Figure 2.3. International agricultural commodity prices, 2000-2012

However, it should be noted that higher international commodity prices do not necessarily translate into an immediate and proportionate rise in domestic price levels in every country (World Bank, 2008). This may be due to a number of factors including domestic supply shocks (such as high transport cost or poor harvest due to bad weather), different policies and trade options adopted by each country as well as asymmetrical information among traders which prevent arbitrage and the transmission of price changes (Conceição *et al.*, 2011).

Notwithstanding the possibilities of an incomplete pass-through or delayed pass-through of international food prices to domestic markets, Conceição *et al.*, (2011) noted that the global food price spike in 2007/08 was transmitted more directly to African markets than in 2010/11. In 2007/08 the domestic price (in United States Dollars) for maize, sorghum and wheat increased more than the international price. While noting that the pass through was large for rice, cassava, and millet within the same period, they pointed out that in 2010/11 the pass-through to local markets was more limited.[15]

This may explain the recent story of food price inflation and the corresponding rise in food Consumer Price Index (CPI) in Nigeria as illustrated in Figure 2.4. The figure shows that food costs almost twice as much in December 2009 as it did in March 2004. More recent data from the Central Bank of Nigeria reveal that food inflation rose in the country to 9.7% in October 2011 from 8.7% in August 2011. In fact, according to CBN (2009), the dominance of imported food items in the menu of most urban households meant the easy and smooth transmission to the domestic economy of global price changes of the commodities. In addition, as Table 2.4 shows, Nigeria is significantly integrated into the world economy through its exports and imports. Table 2.4 traces the values of trade integration of Nigeria over time, starting in 1960. It shows the actual degree of Nigeria's trade integration through exports and imports, measured by total trade (goods and services) as a percentage of Gross Domestic Product (GDP). As the Table shows, from the 1960s up till 1975, the value of import as a percentage of GDP was higher than exports. This trend, however, reversed from the 1980s. Although, Nigeria's trade as a percentage of GDP contribution fluctuated over the period, it has remained above 50% since 1990.

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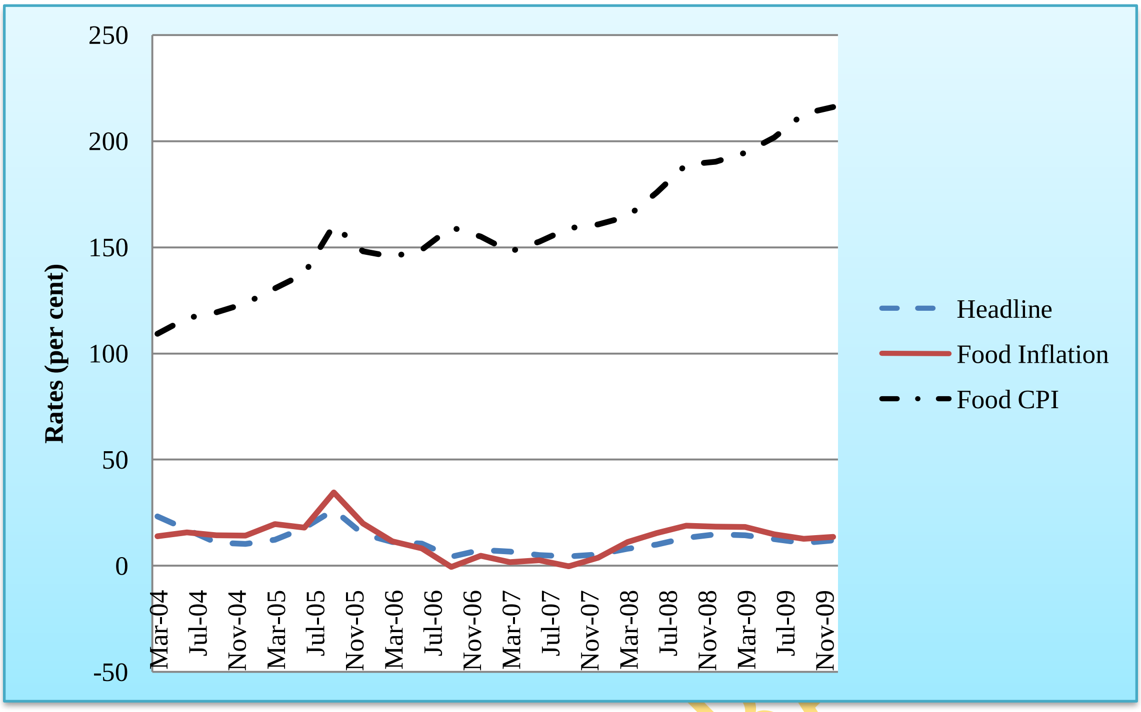
[15] Table 3 in Appendix B shows the Pass-through of food price increases in 2007/08 and 2010/11 for 119 African commodity markets in 14 countries.



Source: Author's drawn: underlying data from CBN Statistical Bulletin, 2009

Figure 2.4. Trends in inflation (headline, food inflation, and food CPI)

Table 2.4. Nigeria's trade integration (trade as % of GDP, 1960-2008)

Year	Export	Import	Trade
1960	9.24	16.92	26.17
1965	10.89	16.02	26.91
1970	8.41	11.21	19.62
1975	18.34	22.83	41.17
1980	29.38	19.20	48.57
1985	16.10	12.44	28.54
1990	43.43	28.81	72.24
1995	44.29	42.18	86.47
2000	53.98	32.03	86.00
2005	46.54	31.05	77.58
2006	42.87	27.73	70.60
2007	41.02	25.94	66.96
2008	41.56	24.67	66.23

Source: World Development Indicators (WDI), 2010

2.4.2 Agricultural trade, policies, and programmes in Nigeria

Prior to the commercial exploration of oil in Nigeria, agriculture dominated Nigeria's export trade, thus, being the primary foreign exchange earner of the country. Although the country's export is now dominated by the oil and gas sector, agricultural products dominate the non-oil exports of Nigeria. For instance, the share of agriculture in non-oil exports was 25% in 2000. Although, it slightly declined to 22.2% in 2006, the share of agriculture in non-oil exports was about 59.4% in 2009 (see Ogunkola, 2011).

Given the *small* position Nigeria occupies in the world economy, Abdullateef and Ijaiya (2010) noted that agricultural development (in particular, food production) may have been constrained by free trade – one of the trade regimes Nigeria has experimented. Notwithstanding the fact that about 65% of the total labour force are engaged in small holder food production, there has been a widening gap, in recent times, between food import and export. This is captured in Table 2.5 which shows the value of food import and export in Nigeria as well as the food-trade balance. The table indicates that the food-trade balance has consistently been negative, thus making the country a net food importer - with rice and wheat comprising the largest shares of imported food in Nigeria (see WTO, 2012). This reflects (i) the fact that Nigeria's domestic food production is below what is required to feed its teeming population; and, (ii) households' preferences for imported food (maybe, partly, due to its affordability). These indications are suggestive of food insecurity, which could be more severe in the event of higher international food prices.

Nyangito (2003) noted that the implication of cheap food imports is a reduced market for domestic agricultural product and a narrowed income source for labour engaged in the agro-allied industries. With a narrowed income source, accessibility of food products becomes a challenge. Furthermore, the Food and Agriculture Organization (FAO) in its State of Food Insecurity in the World, (2006) had stated that Nigeria had about 12 million people reported as undernourished as at 2003. This undernourished proportion of the country's population depicted by percentage was shown to have reduced from about 13% from 1990-1992 to about 9% from 2001-2003. This seeming proportional decline may, in fact, be nullified by population growth.

Table 2.5. Nigeria's food trade (US dollars at current prices, million)

	Food Export	Food Import	Food-trade balance
1996	188.2	934.5	(746.3)
1997	16.9	1,170.1	(1,153.2)
1998	28.5	1,129.6	(1,101.1)
1999	48.7	1,211.3	(1,162.6)
2000	37.5	1,158.6	(1,121.1)
2001	28.2	1,727.3	(1,699.1)
2002	11.8	1,714.7	(1,702.9)
2003	5.7	2,307.8	(2,302.1)
2004	11.5	2,196.1	(2,184.6)
2005	34.1	2,863.5	(2,829.4)
2006	32.8	4,112.4	(4,079.6)
2007	875.9	6,490.2	(5,614.3)
2008	1,053.9	5,908.2	(4,854.3)
2009	2,264.1	4,010.5	(1,746.4)
2010	2,890.5	4,534.8	(1,644.3)
2011	3,640.6	7,932.8	(4,292.2)

Source: WTO (2012)
Note: Food-trade balance is computed as the difference between import and exports; the values bracket represents a negative.

Besides other factors that accounts for low agricultural productivity in Nigeria (as earlier highlighted), and hence, its agricultural trade position, Nigeria's food-trade balance may not be unconnected to the level of investment in the sector. The level of public and private investment in the agricultural commodity sector, which is a prerequisite and important catalyst for agricultural development and food production, appears to be highly inadequate. Ogunkola (2011) noted that despite the surfeit sources of fund available to the sector, investment in the sector is low. For instance, private funding of agriculture in Nigeria is currently below 5% (just like in 1970s) after reaching its all-time peak in 1994 when agriculture share in total loans of commercial banks was about 27%. Some of the factors adjudged to inhibit private sector lending to the sector include infrastructural, financial, technical, economic, and macroeconomic policy constraints.

The share of agriculture in the Federal Government's annual budget ranged between 1.3% and 7.4% from 2000 and 2007 (NPC, 2009). This is below the Maputo Declaration of 10% share of total country budget for agriculture, thus, indicating the low priority previous governments had placed on agriculture. Out of the low budget allocation and fund released to agriculture, expenditure on fertilizer alone was usually over 50% of the agricultural budget allocation. Despite the expenditure on fertilizer, Ogunkola (2011) noted that an average farmer in Nigeria does not have enough fertilizer for one hectare due to unavailability especially at critical times of need, poor quality and short weights of fertilizer, among others. These setbacks could probably have been accentuated by the inconsistencies and instabilities associated with government's agricultural policy in Nigeria.

Nigeria's agricultural policies have a long history. These policies were designed to deal with the constraints limiting the full realization of potentials of the agricultural sub-sectors; improve domestic food production, domestic supply of agricultural raw materials and production of exportable cash crops; and, restoring agriculture to its former status as a leading sector in the economy. The National Development Plans coordinated at the National level from the first (1962-68), the second (1970-74), the third (1975-80) and the fourth (1981-85) were among the earliest policy instruments. This was followed by the Structural Adjustment Plan (SAP) in 1986 which focused, among others, on the diversification of the export base away from oil and the expansion of non-oil exports, especially agricultural exports (UNEP, 2002).

Some of the other policies and programs include: the establishment of Commodity Marketing Boards; Agricultural Research Institutes; National Agricultural Cooperative Bank; River Basin Development Authorities; the National Accelerated Food Production Project; Operation Feed the Nation; and, National Agricultural Land Development Authority. A recent one is the Presidential Initiatives on selected commodities: cassava, rice, vegetable oil development, cocoa, livestock, and fisheries. The Presidential initiative on rice aimed at self-sufficiency in rice production by 2005, and promotes food security and net-export of the product by 2007. However, as at 2011, the country was still far from being self-sufficient in rice production.

Although some of these initiatives and policies have helped in ensuring that the agricultural sector achieved significant progress, but a lot is yet to be accomplished in terms of national food security.[16] Principally, domestic production of most food commodities had not kept pace with demand. Population growth, change of food preference, urbanization, inflation and demand from neighbouring countries are among some of the factors that continue to affect food availability, its accessibility and affordability to most Nigerians.

These setbacks, no doubt, may have contributed to the effects of the 2006-08 food price shocks on the Nigerian economy and households. The Nigerian government, like other African government, adopted a wide range of policy responses to counter the rising food prices. These policy responses which included market (economy-wide) measures impacting prices at the macro level such as cuts in import tariffs and use of strategic reserves; and special interventions to raise agricultural productivity of selected food grains aimed at ensuring adequate supply of food at affordable prices for people. Specifically, among others remedial measures, the Federal Government released an initial tranche of 42,610 tonnes of grains (sorghum, maize and millet) and garri from the National Strategic Grains Reserves (NGSR) and an additional 11,000 tonnes. The grains were distributed to the public at subsidized prices. Government also suspended the 50% levy imposed on imported rice in 2006.

[16] See Table 4 in Appendix B for details on the initiatives.

2.4.3 The Nigerian oil sector-economy linkages

(a) A brief historical background of the Nigerian oil sector

The search for oil in Nigeria can be traced back to 1908, when a German entity, the Nigerian Bitumen Corporation, commenced exploration activities in the Araromi area, West of Nigeria. Although, the search was truncated with the outbreak of the First World War in 1914, oil was later discovered in Nigeria in 1956 at Oloibiri in the Niger Delta. This discovery was made by Shell-BP after half a century of exploration. Following the discovery of crude oil by Shell D'Arcy Petroleum, pioneer production began in 1958 from the company's oil field in Oloibiri in the Eastern Niger Delta with an initial production rate of 5,100 barrels of crude oil per day.

After 1960, exploration rights in onshore and offshore areas were extended to other foreign companies. The companies included Mobil, Agip, Elf, Texaco and Chevron. By the late 1960s and early 1970s, Nigeria had attained a production level of over 2 million barrels of crude oil a day. By this, Nigeria attained the status of a major oil producer, ranking 7th in the world in 1972. It has since grown to become the 6th largest oil producing country in the world. Although production figures dropped in the 1980s due to economic depression, it however increased in 2004 to a record level of 2.5 million barrels per day. Nigeria joined the Organization of Petroleum Exporting Countries (OPEC) in 1971 and established the Nigerian National Petroleum Company (NNPC) in 1977. After this period, Nigeria took a firm control of its oil, in line with the practice of the other members of OPEC.

(b) Performance of the oil sector and Nigeria's economy

The role of the oil sector in the Nigerian economy cannot be overemphasized. Since the production of oil in commercial quantities in the early 1960s and the first oil price shocks in the 1970s, oil has had a profound effect on Nigeria's economy. This sub-section characterizes the performance of the Nigerian oil sector and its linkages to the rest of the economy. Specifically, it focuses on Nigeria's oil production, contribution to government revenues, and gross domestic product (GDP), trade, as well as employment in the sector.

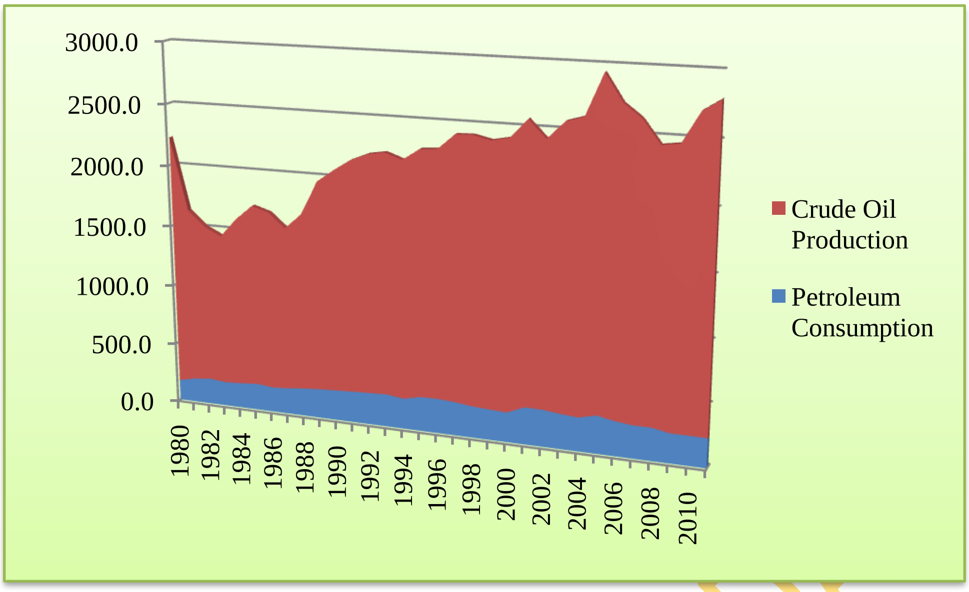
As a member of OPEC, Nigeria agreed to crude oil production limits which have varied over the years. However, OPEC quotas do not appear to have significant impact on production volumes. As shown in Table 2.6, crude oil production in Nigeria has fluctuated over the years. For instance, the percentage change in quantity of crude oil production progressively fell from about 41% in 1971 to about 10% in 1974. It can be observed that the country's contribution to OPEC and world's production increased by about 5% and 2% respectively in 1970 to about 8% and 4% in 1974. The table also indicates significant volatility in crude oil production. For instance, the quantity of crude oil production which declined by 20.9% in 1975 grew increased by 15.9% in 1976. It slightly increased by 0.9% in 1977, and later fell by 9% in 1978. From 1980 to 1983, the quantity of crude oil production showed significant decline. Production quantities, however, increased in 1984 and 1985 before dropping in 1986 and 1987. The volatility in Nigeria's crude oil production which can be observed in the period covered has affected both its contribution to OPEC as well as world production. A principal factor responsible for the observed fluctuations in Nigeria's crude oil production is the unrest in the Niger Delta which has caused significant amounts of shut-in production in the region.

Oil consumption in Nigeria has always been far below production, thus enabling the country benefit from oil exports (Figure 2.5a). Petroleum consumption in Nigeria has also witnessed significant fluctuations since the early 1980s. Petroleum consumption rose from 170,000 barrels per day (bpd) in 1980 to 215,000 bpd in 1982. The recession in the post-1982 period was accompanied by a decline in the level of demand to 208,300 barrels in 1986. However, there has been a steady increase since then. The upward expansion and fluctuations can be attributed to increased local demand due to rapid income expansion, and low and controlled petroleum price; and changes in refinery capacity and refinery output. Other factors include the rapid pace of modernization and industrialization, importation of fuel inefficient second-hand vehicles from abroad, increasing population, smuggling (Adenikinju and Niyi, 2006), and increasing use of generators for power supply. However, as Figure 2.5b shows, it has experienced significant decline in recent years, particularly since 2007. This may be due to the recent past global economic crisis which did not elude the Nigerian economy.

Table 2.6. Trend in Nigeria's crude oil production, and contribution to OPEC and world (thousand barrels per day)

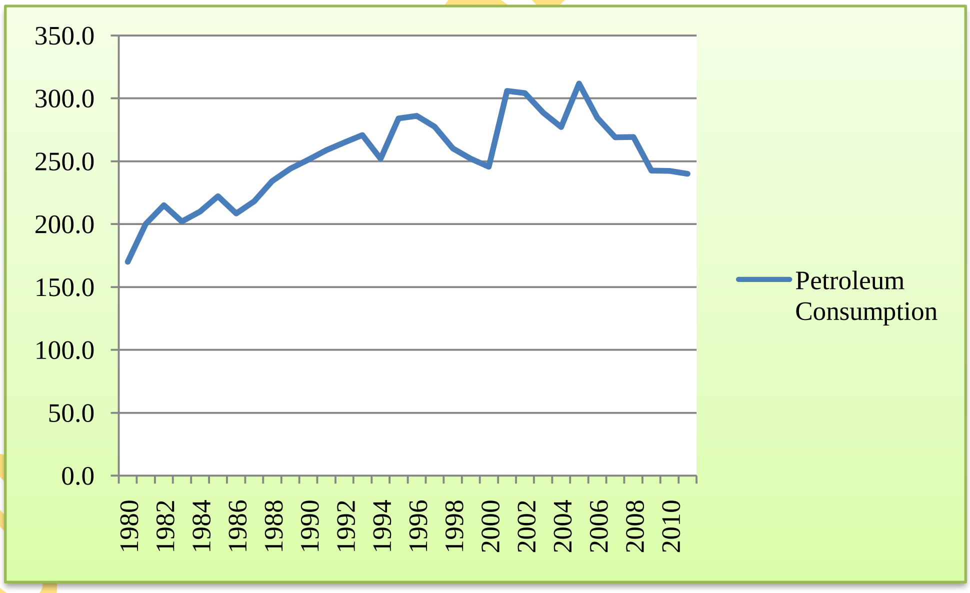
Year	% Change in Nigeria Crude Oil Production	% contribution to OPEC Production	% contribution to World Production
1970		4.8	2.4
1971	41.4	6.3	3.2
1972	18.6	7.0	3.6
1973	13.1	6.9	3.7
1974	9.8	7.7	4.0
1975	-20.9	6.9	3.4
1976	15.9	7.1	3.6
1977	0.9	7.0	3.5
1978	-9.0	6.7	3.2
1979	21.3	7.8	3.7
1980	-10.7	8.1	3.5
1981	-30.3	6.8	2.6
1982	-9.6	7.3	2.4
1983	-4.2	7.5	2.3
1984	11.8	8.4	2.5
1985	7.7	9.7	2.8
1986	-1.9	8.4	2.6
1987	-8.6	7.6	2.4
1988	8.1	7.3	2.5
1989	18.3	8.0	2.9
1990	5.5	8.0	3.0
1991	4.5	8.4	3.1
1992	2.7	8.2	3.2
1993	0.9	8.0	3.3
1994	-1.5	7.8	3.2
1995	3.2	7.8	3.2
1996	0.4	7.7	3.1
1997	6.6	7.8	3.2
1998	1.0	7.6	3.2
1999	-1.1	7.8	3.2
2000	1.6	7.5	3.2
2001	4.2	8.0	3.3
2002	-6.1	8.0	3.2
2003	7.4	8.1	3.3
2004	2.4	7.7	3.2
2005	12.8	8.2	3.6
2006	-7.1	7.7	3.3
2007	-3.7	7.5	3.2
2008	-7.8	6.7	2.9
2009	2.0	7.2	3.1
2010	11.2	7.1	2.8
2011	3.9	7.3	2.9

Source: Computed by the Author; underlying data is from the Energy Information Administration, December 2010 International Petroleum Monthly.
Note: OPEC[2]: Organization of the Petroleum Exporting Countries: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.
2010 and 2011 values were computed from an undated version of the database from http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm



Source: Author's drawn; underlying data from Energy Information Administration,
See http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm

Figure 2.5a. Oil production and petroleum consumption in Nigeria, 1980-2011 (Thousand barrels per day)



Source: Author's drawn; underlying data from Energy Information Administration,
See http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm

Figure 2.5b. Oil consumption in Nigeria, 1980-2011 (Thousand barrels per day)

The oil sector maintains a very strong fiscal linkage with the rest of the economy. In terms of its contribution to GDP, its average contribution increased from about 18percent between 1971-75 period to about 33% between 1996-00 period. Its average contribution between 2001 and 2005 stood at 26.7%, while annual contribution from 2006 showed a steady decline from about 22% to about16% in 2010 (see Table 2.7). It is, however, worthy to mention that not all of the industry's value added is retained in the country because of the massive involvement of foreign operators in Nigeria's oil industry. In fact, a substantial proportion is sent out in the form of factor payments profits, dividends, interest, fees, and wages and salaries paid abroad (Odularu, 2010).

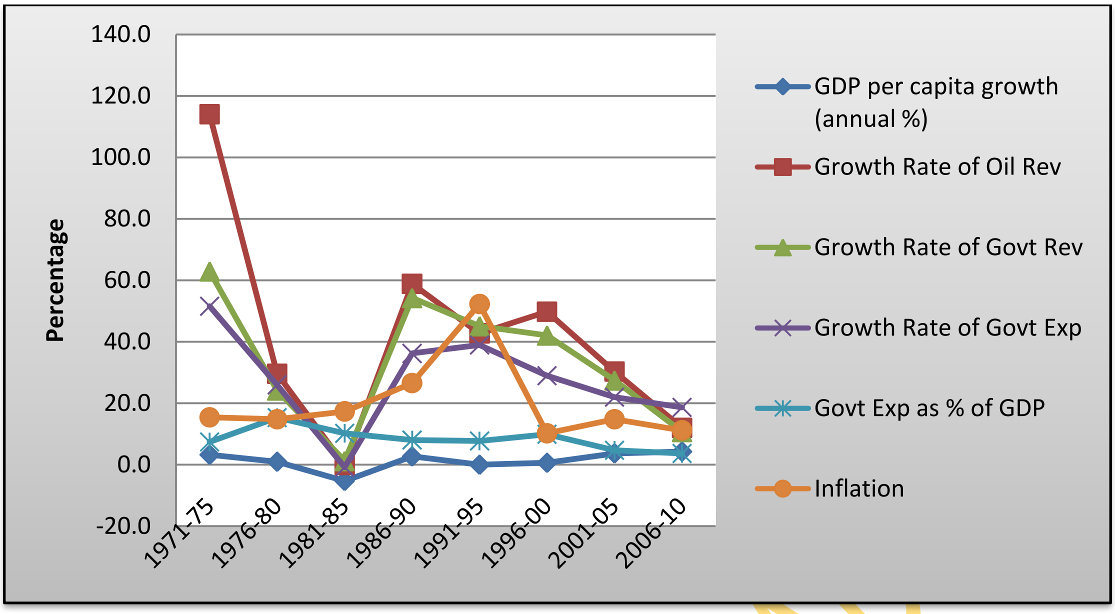
The Table 2.7 further reveals that the fiscal sector (government revenue and expenditure) is strongly dependent on the oil sector. Oil revenue as a percentage of total government revenue ranged between 63.5% and 88.6% from 1970 to 2010 compared with an average of about 26% non-oil revenue share over the same period. Figure 2.6 clearly indicates a strong dependence of government revenue and expenditure on oil revenue. For instance, as oil revenue increased by about 30% between 1976 and 1980, government revenue and expenditure increased by about 24% and 26% respectively during the same period. Similar patterns are observed over the period (between 1971 and 2010) except in the 1981-85 period, when government revenue increased by 1.2% as oil revenue fell by 0.1%, and in 2007.

The co-movement is a reflection of a number of factors including: fluctuations in crude oil production in Nigeria; volatility in crude oil prices; and the more favourable fiscal arrangements obtained by the government as a result of its improved bargaining position with the oil companies over the years. The overall implication of the observed pattern is that fluctuations in oil production and export directly affect government earnings which ultimately affect the domestic economy.

Table 2.7. Trend in selected economic indicators in Nigeria

Year	GDP per capita growth (annual %)	% of Oil in Total GDP	% of Oil Revenue in Total Revenue	% of Non- Oil Revenue in Total Revenue	Growth Rate of Oil Rev	Growth Rate of +Govt Rev	Growth Rate of Govt Exp	Govt Exp as % of GDP	Inflation
1971-75	3.2	17.8	63.5	36.5	114.0	62.9	51.5	7.4	15.4
1976-80	0.9	22.9	75.8	24.2	29.6	24.2	26.0	15.3	14.8
1981-85	-5.3	34.5	69.6	30.4	-0.1	1.2	-0.8	10.2	17.4
1986-90	2.6	34.3	71.4	28.6	58.8	54.2	36.2	8.1	26.6
1991-95	-0.1	33.9	80.4	19.6	42.7	45.1	38.9	7.7	52.3
1996-00	0.6	32.9	75.9	24.1	49.8	42.0	29.0	9.9	10.2
2001-05	3.7	26.7	79.9	23.5	30.3	27.4	21.9	4.7	14.8
2006-10	4.2	18.2	77.9	21.9	11.9	10.7	18.6	3.7	11.2

Source: Data for GDP per capita growth (annual %) is from WDI, 2010; other data are computed by the Author from data sourced from the CBN Statistical Bulletin, 2010.
* The data for GDP per capita growth 2009 and 2010 were computed from data in the CBN Statistical Bulletin, 2010 because the available data from the WDI, 2010 ends at 2008.
+Govt means Government



Source: Author's drawn; underlying data from Table 2.7

Figure 2.6. Co-movement of oil revenue, and government revenue and expenditure

With an estimated population growth of 2.8% per annum, the figure reveals that besides population growth, the fluctuations in GDP per capita growth may not be unconnected with government expenditure which depends heavily on oil revenue. The reliance of the Nigerian economy on the oil sector has also introduced large distortions into the economy. Weak fiscal discipline evidenced by volatile fiscal spending tends to have contributed to these distortions. In fact, fiscal expansions financed by oil revenues often resulted in domestic currency appreciation; thus, creating Dutch-disease concerns which led to a shift in the structure of domestic incentives to the import and non-tradeable sectors, as well as the policy of maintaining subsidized domestic energy prices in the face of rising domestic inflation rates (Adenikinju and Niyi, 2006). As Table 2.7 shows, inflation figure is seen to experience significant rise from an average of 15.4% in 1971-75 period to 52.3% in the 1991-95 period. It, however, dropped significantly to 11.2% in 2006-10 period.

One key issue in the Nigeria's oil-economy linkage is that Nigeria experiences great difficulty in implementing its fiscal policy due to its dependency on the oil sector and the volatility in oil prices. Since fiscal income in Nigeria depends largely on oil income which is remarkably influenced by oil price volatility, economic progress appears to be dependent, to a large extent, on activities in the international oil market arena.

The extent to which fiscal income in Nigeria continues to be determined and affected by oil prices depends on the balance between the demand for and the supply of energy, the level of economy in energy consumption, and the speed of development of substitute fuels, as well as the level of reliance of the economy on the sector.

(c) The oil sector and Nigeria's economic performance: the role of world oil prices

(c.1) A brief history of oil price

Prior to the early 1970s, the international price of oil was very stable, moving up only slightly. From the early 1970s to the early 1980s, the price of oil rose dramatically in a sequence of steps associated with two major events: the Arab OPEC oil embargo associated with the Kippur war; and disruptions in the supply of oil from the Middle East oil-producing countries resulting from Iranian revolution and the Iran-Iraq war (see Figure 2.7).

Crude-oil prices were relatively stable from 1974 to 1978, ranging from $12 to $14 per barrel. It, however, pivoted upwards from $14 to $35 in 1979 following a fall in world production caused by Iranian revolution and Iran-Iraq war. The world oil boom and bust, also known as the "oil shock", of 1973-74 and 1979-80 were followed by considerable turmoil in various markets including global recessions. Nigeria was able to reap from its oil production until the mid - 1980s. Prior to this time, OPEC tried to stabilize the price of oil through production quotas. However, cheating on production quotas by member countries, global recession, and conservation efforts led to a major oil price collapse to below $10 per barrel in 1986.

The Iraqi invasion of Kuwait in August 1990 caused considerable oil price spikes as oil price rose from around $21 per barrel to around $40 per barrel. However, within 6 months the price returned to pre-disruption levels. This was because Saudi Arabia and several other OPEC producers increased production so as to nearly fully offset the losses of Iraqi and Kuwaiti supplies.

Afterwards, the price of oil remained relatively stable until the “9-11 attack”[17] where oil prices started increasing on average from US $25 per barrel in 2002 to US $55 per barrel in 2005. This steep upward trend in the price of crude oil continued, reaching a record nominal high of $147 in mid-2008 before plummeting to $46 a barrel. The trend in oil prices has led to increasing concern, both abroad and in Nigeria, about the macroeconomic and household implications of oil price fluctuations.

[17] “9-11 attack” is used to describe the largest terrorist attack in world history that occurred on September 11, 2009 as 2 hijacked airplanes crashed into the twin towers of the World Trade Center in New York City and 1 hijacked plane crashed into the U.S Department of Defence’s Pentagon headquarters, and another hijacked plane crashed into a rural part of Pennsylvania.

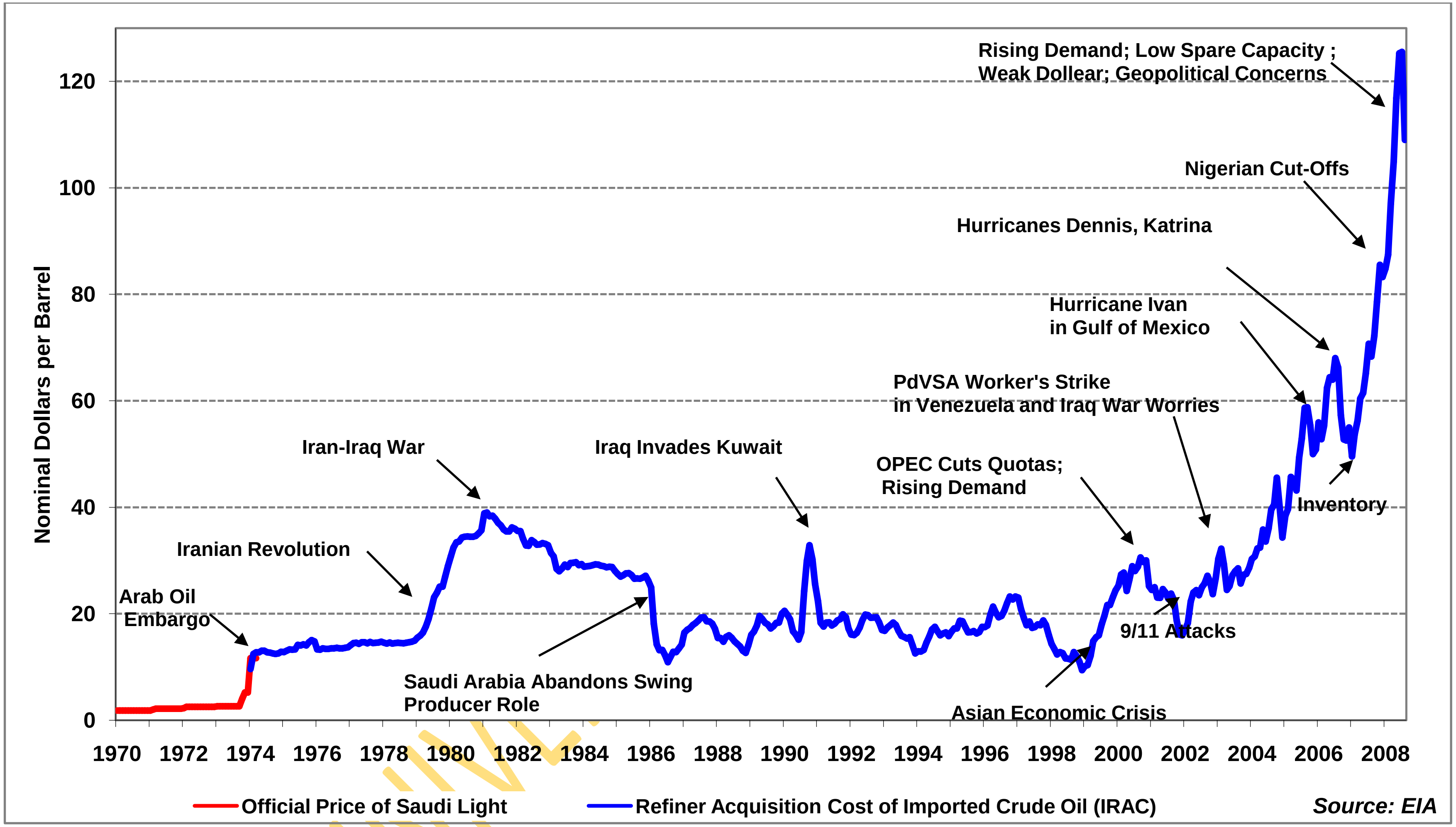


Figure 2.7. World Norminal Oil Price Chronology 1970-2008[18]

[18] The price data graphed above are in nominal terms (that is, they are in "dollars-of-the-day" and have not been adjusted for inflation). For oil prices in real terms that **are** adjusted for inflation, please see, Appendix B1, and B2 for prices adjusted by quarterly GDP deflator. Note that, EIA means Energy Information Administration.

(c.2) World oil prices-Nigeria economy linkage

World oil prices matter for an economy in several ways. Changes in oil prices directly affect not only transportation costs but also the prices of goods made with petroleum products among others. Oil price shocks induce greater uncertainty about the future, which may lead to firms' and households' delaying purchases and investments. It also leads to reallocations of production factors such as labour and capital between energy intensive sectors of the economy and those that are not energy-intensive (Sill, 2007).

Increase in petroleum prices tends to have a contractionary effect on world demand and growth in the short term. It generates higher inflation, with the magnitude depending not only, in part, on the extent of labour market flexibility and the ability of producers to pass on cost increases to consumers but also policy responses and supply side effects (IMF, 2005).

Oil price change represents the main commodity price shock in Nigeria due to the country's over-reliance on revenue generated from crude oil as well as its import-dependence of refined petroleum. For instance, crude oil export revenues represent about 90% of total export earnings and on average about 70% of government revenues in annual budgets (see CBN, 2009).

Over time, the impacts of rising oil prices have always had connections with some movements in key macroeconomic variables in Nigeria. For instance, during the first oil shock experience (1973-74) the value of Nigeria's export measured in US dollars rose by about 600% with the terms of trade rising from 18.9% in 1972 to 65.3% by 1974; the value of import (measured in Naira) also increased by about 42% during the 1973-74 period. Government revenue which was about ₦1.4m in 1972 rose by about 168% in 1974. As a percentage of GDP, government revenue which was 8 per cent of GDP in 1972 rose to about 20% in 1975. This resulted in increased government expenditure owing largely from the need to monetize the crude oil receipts (CBN, 2009; Nnanna and Masha, 2003).

With a decline in the price of oil to about $10 per barrel in 1986 from a peak of $39 per barrel in 1981 due to repeated failure by OPEC to set production quotas low enough to stabilize prices[19], it can be seen that government revenue declined except in

[19] The failure is attributed to non-compliance by various members of OPEC who produced beyond their quotas.

1984 and 1985 (at which point oil price was relatively stable (see Table 2.8)[20]. As the price climbed to $19 per barrel in 1987 government revenue is noted to increase by about 101%. Until 1986, investment declined significantly from 1982. Import is also observed to register significant decline. Household final consumption is seen to increase, despite the decline in government revenue. This may be attributed to a number of factors including the fact that households are not directly affected by changes in international oil price since government regulates domestic energy prices.

Growth in government revenue tended to *weakly* respond to fluctuations in the price of oil between 1987 and 1990, increasing marginally in 1988 as oil price decline to $12.6 in the fourth quarter. The weak response (increases) in government revenue despite fluctuation in oil price may partly be attributed to government's policies during the period which was geared to diversifying the economy. It can been seen that as the price of oil spiked in 1990, hitting $32.9 per barrel - due to lower production, uncertainty associated with the Iraqi invasion of Kuwait and the ensuing Gulf War, government revenue increased but less than the previous year. Investment, household final consumption, imports and exports registered remarkable growth afterwards, except in some cases. One interesting observation is that government revenue tends to move in tandem with exports. This is not surprising given that exports in Nigeria have been oil-driven, and the bulk of government revenue comes from crude oil receipts.

When the oil price increased from $25 per barrel in 2002 to $55 per barrel in 2005, Nigeria's imports value increased by about 85% while the country recorded increases in GDP growth from about 1.5% to 6.5%; money growth rose sharply from 21.6% to 30.8%. It is also observed that when oil prices reached its record nominal high of $147 in mid-2008, GDP increased by about 29% from its 2008 first-quarter figure but decreased by about 19% following the sharp decline in oil prices to $46 a barrel in December, 2008 (CBN 2009, 2010). While it is no surprise that import bills go up when oil prices increase, it is surprising that GDP often goes up too. A possible explanation for this is that although higher oil prices increase the import bill, there are partly offsetting increases in external receipts arising from crude oil exports.

[20] It may be quite useful to compare the figures reported in the Table with the trend in Figure 2.7.

Table 2.8. Change in selected macroeconomic variables in Nigeria (%)

Year	Investment	Household Final Consumption	Imports	Exports	Government Revenue
1982	-5.9	6.4	-16.1	-25.6	-14.0
1983	-22.2	15.8	-17.3	-8.6	-8.1
1984	-31.4	21.7	-19.4	21.1	7.1
1985	-3.8	15.0	-1.6	29.0	33.7
1986	29.0	4.5	-15.3	-23.9	-16.3
1987	34.2	47.4	198.5	240.3	101.5
1988	15.3	40.4	20.1	2.7	8.7
1989	52.7	18.3	43.9	85.8	95.2
1990	49.6	40.5	48.1	89.6	82.1
1991	12.6	16.7	95.7	10.6	2.9
1992	56.7	80.6	60.0	69.2	88.6
1993	36.9	34.6	15.7	6.4	1.2
1994	8.9	21.4	-1.7	-5.8	4.7
1995	34.4	127.3	363.9	361.4	127.8
1996	43.8	53.1	-25.5	37.8	13.8
1997	19.0	-1.6	50.3	-5.2	11.3
1998	-0.3	13.4	-1.0	-39.4	-20.5
1999	-4.4	3.5	3.0	58.1	104.7
2000	42.9	1.0	14.2	63.6	100.8
2001	12.4	48.8	37.9	-4.0	17.1
2002	34.3	50.2	11.4	-6.6	-22.4
2003	73.3	27.2	37.5	77.0	48.7
2004	-0.3	22.6	-4.5	49.1	52.2
2005	-6.8	28.2	41.0	57.4	41.5
2006	92.3	6.9	11.0	1.1	7.5
2007	25.1	32.5	25.8	13.4	-4.2
2008	6.0	0.5	32.7	22.3	37.6
2009	48.6	19.7	-1.7	-17.8	-38.4
2010	31.5	-7.0	56.9	32.1	50.8

Source: Computed by Author; underlying data from CBN Statistical Bulletin, 2010

It is, however, worth mentioning that while rises in the international price of crude oil can be translated into higher domestic petroleum prices, it is not necessarily the case in Nigeria. The impact of higher oil prices is not directly felt by households in Nigeria. This is because of government's involvement in the energy market, in terms of regulating price of petroleum products (Petroleum Motor Spirit – PMS, in particular). The fact is that the consumers in Nigeria pay a lower price for fuel than is obtainable in the international market. However, global market conditions and unsustainable fiscal deficits show that Nigeria's government can no longer sustain a high level of fuel subsidy. With its involvement in the commercial energy market through continuous funding of the *increasing fuel subsidy*[21] a huge fiscal burden is placed on the government. Arguably, fuel subsidy constrains government's ability to fund welfare-improving programmes, and thus, informed the policy-shift towards the removal of fuel subsidy.

(d) The oil sector and the transport sector of the Nigerian economy

Besides linkage via the fiscal angle, there are other ways through which the oil sector is linked to the rest of the economy and, ultimately, the households. Oyejide and Adewuyi (2011), however, noted that there is little or no inter-sectoral linkage between the oil sector and the other sectors of the economy. They argued that if there were linkages, domestic subsidiary firms would participate in the oil sector activities, and thereby generate employment and income for the domestic residents. One reason adjudged for the lack of linkage is the capital intensive nature of activities in the oil sector, scarcity of capital in Nigeria, and lack of local expertise.

Despite the dearth of linkage between the oil sector and other sectors of the Nigerian economy, there is some measure of interdependence among the sectors. Essentially, the other sectors of the economy depend on the output of the oil sector for their productive activities. Of particular interest is the transport sector. This is because the transport sector plays a vital role in the production of other sectors' output. The linkages of this sector and the oil sector are discussed below.

The transport sector in Nigeria consists of road, air, water, and rail systems. Road transport is considered the most commonly used mode of transportation in Nigeria. The road transport component includes passenger cars and light-duty vehicles, such as

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[21] This actually means the amount of income forgone by the Federal Government of Nigeria for not allowing consumers in Nigeria to pay the internationally competitive price of PMS rises as the international price of oil increases.

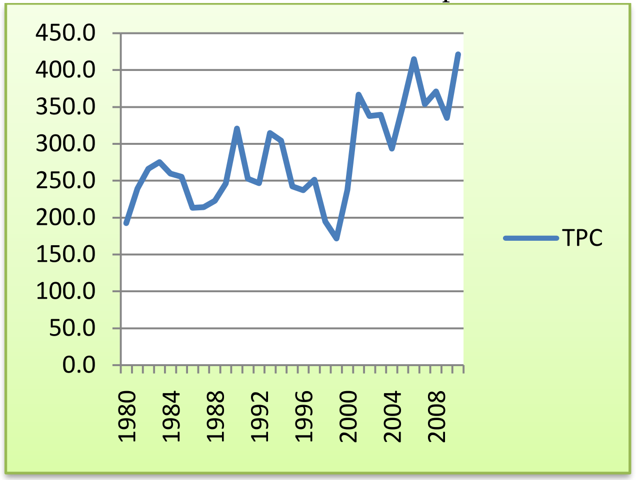
automobiles, sport utility vehicles (SUVs), minivans, small trucks, and motorcycles. It also includes heavy-duty vehicles, such as large trucks used for moving freight and buses for passenger travel. Road transport involves the conveyance of passengers, livestocks, farm products, and merchandise (Badmus *et al.*, 2012). Obih (2001) noted that gasoline engines represent 60% of vehicle fleet, and road transport accounts for about 90% of passenger/freight movements. While water transport whose components include ocean, coastal water and inland water transports, and the rail transport system are other important means of transportation in Nigeria especially for moving heavy traffic (where speed is not as important as cost), air transport (although more costly than other modes of transport) is most preferred if speed and safety are major considerations.

The energy use in the transport sector is the petroleum consumed in moving people and goods via the aforementioned mode of transports.[22] Figure 2.8, panel A, shows that the total petroleum consumption (TPC) by the transport sector has maintained an upward fluctuation over the last three decades. Panel B shows that road transport consumes over 80% of TPC, except in 1990 where its consumption share in TPC was 70.6%. The panel also shows that air transport consumed a larger share of the remainder of TPC (about 15% between 1980 and 1985, 26.2% in 1990, 16.3% in 2001, and 10% in 2008). Rail transport had the least share in TPC over period, consuming less than 1% of TPC.

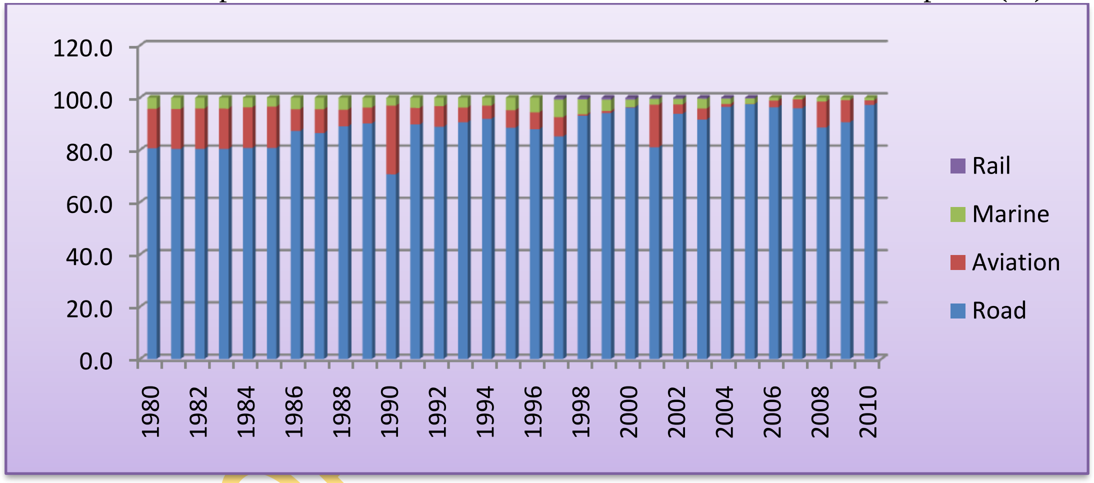
Panel C shows a declining trend in road transport consumption share of automotive gas oil (that is, diesel oil) as a percentage of TPC. Its consumption share declined from 17% in 1980 to 5.5% in 2010. Within this same period, road transport PMS consumption share increased from 63.2% to 91.8% (this is notwithstanding the several downward spikes observed during the period which may be attributed to the government's revisions of PMS prices). Panel D shows declining consumption share of diesel oil and fuel oil in total petroleum consumption by marine sub-sector. The downward trend in the demand for diesel oil may be due to policy reform in the downstream sector of the petroleum industry which saw the removal of subsidy on price of diesel oil.

[22] In some advance countries, the energy use in the transport sector includes electricity and solar.

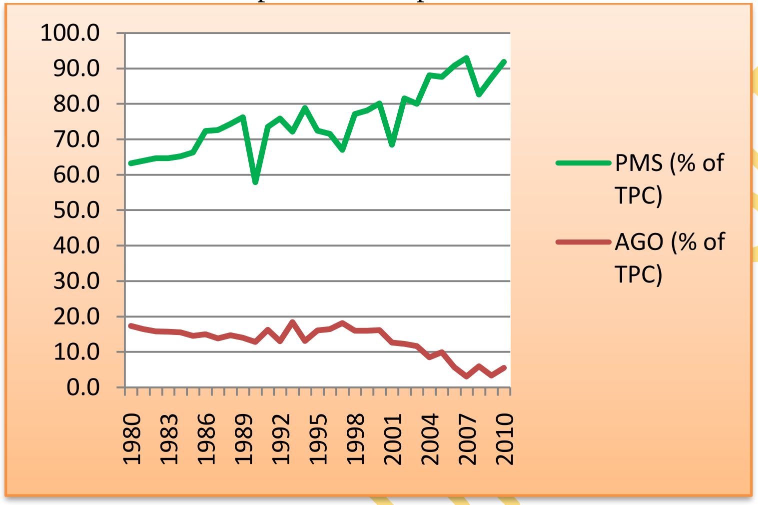
Panel A: Total Petroleum Consumption



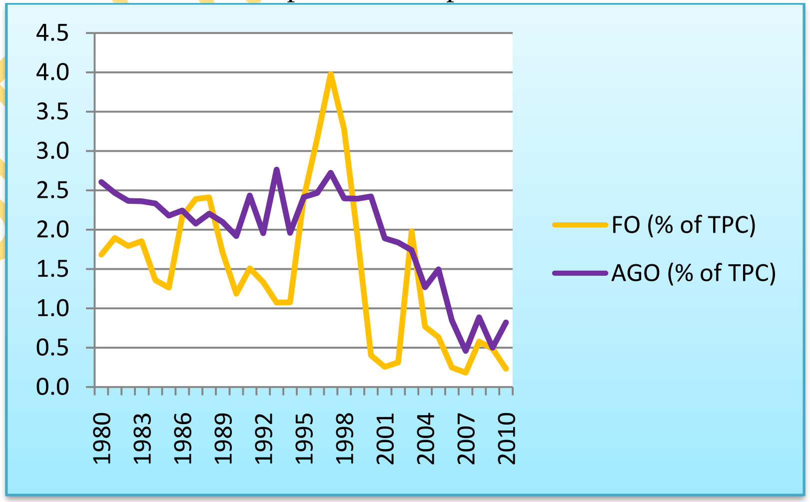
Panel B: Transportation Sub-sector Share in Total Petroleum Consumption (%)



Panel C: Road transport consumption of PMS and AGO



Panel D: Marine transport consumption of FO and AGO



Source: Author's drawn; underlying data from Table 5 in Appendix B.
Note: TPC = Total Petroleum Consumption, PMS = Petroleum Motor Spirit, AGO = Automotive Gas Oil, FO = Fuel Oil.

Figure 2.8. Energy consumption values in the Nigerian transportation sector (1980 to 2010)

As regards the transport sector's contribution to GDP, Figure 2.9a shows that the sector's share (naira value) in GDP was higher than the other activities in the services sector from 1981 to 1987. Although it was overtaken by finance and insurance, utilities, and communication sub-sectors in 1988, 2001, and 2008 respectively, contribution of the transport sector to GDP has continued to increase. In fact, it increased from N7,982 million in 1981 to N20,755 million in 2010. From this value, Figure 2.9b indicates that road transport contributes the most in the sector's contribution to GDP. Its contribution was over 80% between 1981 and 2010, except in 1983 and 1984 when it registered 73.4% and 76.8% respectively. Table 2.9 clearly shows the declining contribution of water and air transport in transport GDP. It also shows a declining trend in rail transport's share from 3.12% in 1981-1985 period to less than 1% from 1991-1995 period onwards. This signifies that railway is a very small division of Nigeria's transport subsector.

The relative share of the sub-sectors in transport GDP may be reflective of federal allocation in the transport sector. For instance, the road subsector which accounted for 54% of the Federal Government's total public sector planned capital investment in transport in the First National Development Plan (1962-1968). The share increased to more than 70% during the Third (1975-1980) and Fourth (1981-1985) Development Plan periods. In fact, up to 1999, planed allocations and actual expenditure on transport sector was dedicated more on the road sector (see Njoku and Ikeji, 2012).

EIA (2011) noted that growth in economic activity and population are the key factors that determine transportation sector energy demand. Increased economic activity leads to growing income per capita; and as standards of living rise, demand for personal transportation increases. In Nigeria, other factors that have increased transportation energy consumption includes subsidized and regulated energy prices (Adenikinju and Niyi, 2006), and poor road conditions which increases the hours spent, hence, energy consumed on the road (see Njoku and Ikeji, 2012). These factors – subsidized and regulated energy prices, and poor road conditions, have significant implication on the final price of most goods – agricultural, manufactured and mining products (Njoku and Ikeji, 2012).

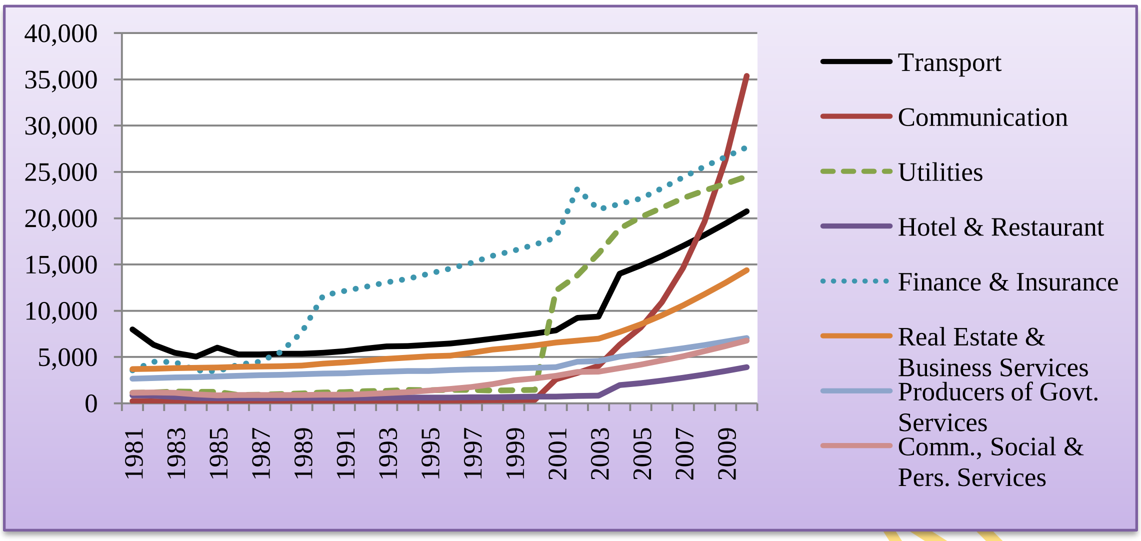
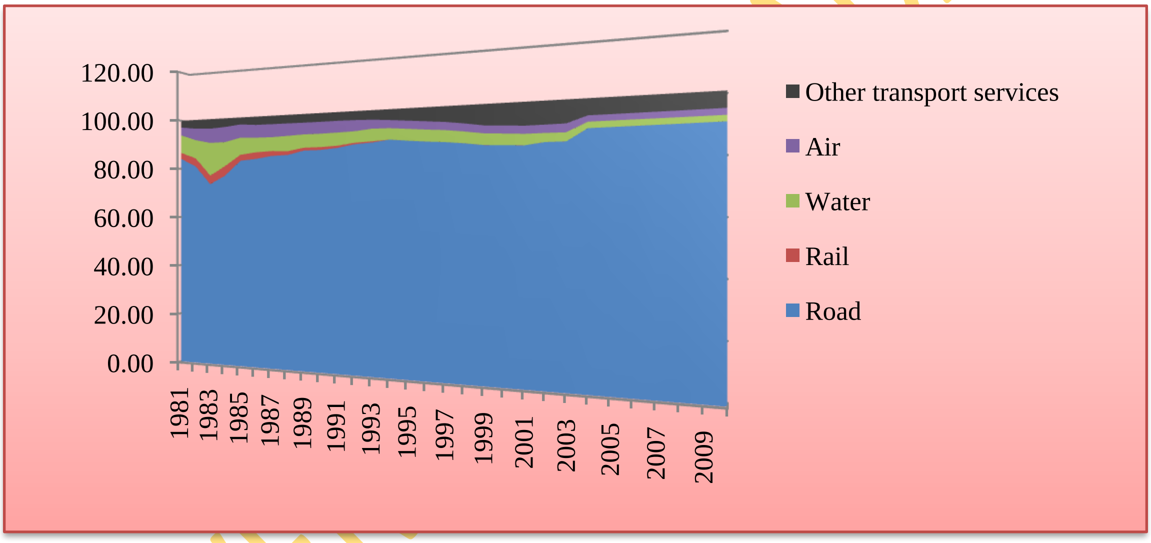


Figure 2.9a. Contribution of services sub-sectors in GDP, 1981-2010 (n'million)



Source: Author's drawn; underlying data from CBN Statistical Bulletin, 2010

Figure 2.9b. Transport sub-sector share in transport GDP, 1981-2010 (%)

Table 2.9. Transport sub-sector share in transport GDP, 1981-2010 (%)

	Road	Rail	Water	Air	*Other T services
1981-85	79.56	3.12	8.94	5.06	3.32
1986-90	84.62	1.65	5.52	4.85	3.35
1991-95	87.69	0.38	4.54	3.61	3.78
1996-00	86.27	0.02	4.22	2.90	6.59
2001-05	87.23	0.01	2.90	2.60	7.25
2006-10	90.11	0.01	2.10	2.18	5.60

Source: Computed by author; underlying data from CBN Statistical Bulletin, 2010
Note: Values are in five-year average.
* Other Transport Services

How changes in the international price of oil and government regulation of the energy market affects the domestic price of oil and the transport sector, to a large extent, has a bearing on the cost of production in the other sectors which depend on oil for production.

Evidence so far reveals the dependence of the Nigerian economy on performance of its oil sector, and thus, on the variability of oil prices. The dominant role of the oil sector has pushed agriculture, the traditional mainstay of the economy, to the background. A plausible justification for the impact of rising oil and food prices on economic activity and inflation in Nigeria depends not only on the supply side effects and food import dependence but also on inefficient management of crude oil receipts by the government. The ongoing reforms, fiscal restraint, efforts to check corruption and the establishment of the Sovereign Wealth Fund, if sustained, should make Nigeria less vulnerable to shocks to world oil price. Also, if government fully commits to allocating, at least, 10% of its national budget (based on the 2003 Maputo declaration)[23] to agriculture and agricultural research and development, the country may attain some level of food sufficiency and possibly gain from international food price increases.

2.5 The Nigerian households, income distribution and poverty in Nigeria

Standard definitions of households usually include the intersection of some keywords relating to residency requirements, common food consumption and common intermingling of income or production decisions. NBS (2009) defines a household as constituted by a group of people living together and maintaining a unique eating arrangement. In this section, some characteristics of the Nigerian households such as number of persons living in households, as well as household's size, spread, and location are discussed. Information on key aspects of the household composition, income sources, consumption expenditure, and access to credit are also discussed because they are associated with the household's ability to cope with shocks. In line with this, trends in income distribution and the poverty profile of the country is also discussed in this section.

According to Nigeria Demographic and Health Survey 2008, households in Nigeria are predominantly headed by men (81%) and less than one in five (19%) are headed by

[23] Heads of States and Government of the African Union assembled in the second ordinary session of the Assembly (10-12 July, 2003), among other agreements, committed themselves to allocating at least 10% of national budgetary resources for agricultural development.

women. Female-headed households are more common in urban areas than in rural area; and they are typically poorer than male-headed households.[24] Also, economic resources are often more limited in larger households. The survey further reveals that average household size in Nigeria is about 4.4 (which is slightly lower than the 2004 estimate of about 4.7 persons). The figure is slightly lower in urban areas (4.1 persons) than rural areas (4.6 persons). The proportion of households with nine or more members is higher in rural areas.

The Nigerian Living Standard Survey (NLSS) (NBS) 2004 shows that labour is the source of more than half of the Nigerian households' incomes. This is not surprising given that labour is the most important asset of poor households (see Agenor, 2003). Other sources of income (based on the survey) include dividends received from firms, returns on land, and transfers from government and the rest of the world. Among the activity sectors that employ labour, the Harmonized Nigeria Living Standard Survey (HNLSS), 2008/09, reveals that agriculture remains the highest employer of labour in Nigeria. The survey indicates that more males and female work in agriculture in the rural areas (56.2% and 55.3%) than in the urban areas (46.5% and 46%). Also, the survey showed that 38.0% of the working population aged 5 years and above were in self-employed agricultural, 25.7% in unpaid family businesses, self-employed non-agricultural (10.3%), and employee with government sector (4.3%).

Despite the involvement of rural households in various farming activities, the generality of their income remain low. Most of the net food buying rural households in Nigeria are not farmers but are labourers or businessmen. These household incomes are likely to depend on the expenditures of net food sellers, especially in rural areas where the primary economic activity is food production. Hence, lower food prices could lead to lower incomes of net food sellers, which in turn could lead to reduced demand for labour and services from net food buyer households. This is particularly disturbing because households in Nigeria spend most of their incomes to purchase and consume food. For instance, the households' expenditure estimates and patterns (see Table 2.10) reveals that expenditure share of households on food purchase stood at

[24] This is consistent with the common assertion that female-headed households and women per se, are particularly more vulnerable to shocks given their socially constituted roles and socially learned behaviours.

about 40% in 2004.[25] Although it reduced by about 4% in 2010, the share of food in total household expenditure (58.37%) in 2010 was higher than its non-food share (41.63%), and also higher than the 2004 total food share. Breisinger *et al.,* (2009) noted, more specifically, that poorer households typically allocate a larger portion of their income on food than wealthier households. Hence changes in the prices of foods are likely to affect poorer households more.

[25] The households' expenditure estimates and patterns provided in the HNLSS, 2010 compute all individual member household expenditure into their primary headings for the purposes of poverty profile. It also includes some non-monetary measures such as consumption from own produce, uses value of owned assets and inputted owner occupied rents.

Table 2.10. Expenditure share of households for 2003/04 and 2009/10 (%)

Items	2003/04	2009/10
Food Purchase	39.96	36.30
Food Consumption	14.42	22.67
Total Food Share	54.38	58.37
Education Share	5.22	1.40
Health Care	7.78	7.51
Rent Share	11.05	6.59
Non Food Share	45.62	41.63
Total Food & Non Food Expenditure	147.34	310.63
Per Capita Expenditure	38.57	97.22

Source: Nigeria Poverty Profile 2010 - NBS, 2012

A sector-level assessment of household livelihood reveals that 11.6% of the households in the rural sector reported to be very poor while in the urban sector 6.1% were very poor. In the rural sector 41.9% were poor while 30.1% in the urban were poor (NBS, 2012). This report is not new knowledge as the problem of poverty in Nigeria has for a fairly long time been a cause for concern to the government. The poverty profile for Nigeria shows that the incidence of poverty increased sharply between 1980 and 1985 from 27.2% to 46.3%, and between 1992 and 1996 from 42.7% to 65.6%. Although, it reduced slightly between 1985 and 1992, and between 1996 and 2004, however, the proportion in poverty, in 1995, was about five million higher than the 1985 figure, and in 2004, about two million higher in than the 1996 figure (see Table 2.11a).

Poverty in Nigeria, like in many developing countries, is essentially a rural phenomenon as most of the impoverished people live in the rural areas where they derive their livelihood from farming. Though, urban poverty exists and is also becoming an increasing concern, as reflected in the worsening trend in urban welfare indicators (see World Bank, 1996), rural poverty is a much wider issue than the former (see Table 2.11b). The rising incidence of urban poverty as shown in Table 2.11b is not surprising given the high rural urban migration that accompanied the impetus to development generated by oil revenues. Moreover, the collapse of oil exports income (during the episodes of negative oil shocks), and the massive importation of food to meet the declining production capacity in the agricultural and industrial sectors, may have severely contributed to the rising urban poverty.

Table 2.11c show that households whose heads are engaged in agriculture and forestry have the highest poverty incidence, depth and severity while those whose heads are engaged in professional and technical occupation have the lowest poverty incidence and depth. Those engaged in production and transport have the lowest poverty severity. The primary causes of poverty differ across rural-urban divide. In rural areas, the major reasons for being poor are connected to agriculture: high cost of agricultural inputs, low agricultural production, unavailability of agricultural inputs, and lack of capital to expand agricultural business, among others. However, urban poverty is mainly connected to non-agriculture related factors such as lack of capital or credit to expand business, poor salaries, and high commodity prices among others (see NLSS, 2004).

Table 2.11a. Trends in relative poverty headcount, 1980-2010

Year	Poverty Level (%)	Estimated Total Population (Million)	Population in Poverty (Million)
1980	27.2	65.0	17.1
1985	46.3	75.0	34.7
1992	42.7	91.5	39.2
1996	65.6	102.3	67.1
2004	54.4	126.3	68.7
2010	69.0	163.0	112.5
2011*	71.5	168.0	120.1

Source: National Bureau of Statistics, HNLSS (2010)
*The 2011 figures are estimated

Table 2.11b. Relative poverty incidence in % by sector (1980-2004)

Year	Urban	Rural
1980	17.2	28.3
1985	37.8	51.4
1992	37.5	46.0
1996	58.2	69.3
2004	43.2	63.3
2010*	61.8	73.2

Source: National Bureau of Statistics (2009)
*The 2010 figure was obtained from NBS, 2012

Table 2.11c. Poverty profile by occupation of household head

Occupation	Poverty Headcount	Poverty Depth	Poverty Severity
Professional & Technical	36.6	14.7	8.2
Administration	43.9	23.6	16.5
Clerical	41.1	16.3	8.7
Sales & related	43.9	17.3	9.2
Service Industry	45.9	18.1	9.5
Agricultural & Forestry	66.3	27.9	15.1
Production & Transport	40.9	15.6	7.9
Manufacturing & Processing	44.5	17.8	10.1
Others	48.9	18.8	10.2
Student, retired, unemployed or inactive	45.9	18.1	9.8
National	***54.7***	***22.5***	***12.2***

Source: National Bureau of Statistics (2009)
Note: Poverty is measured here by the Absolute Poverty Line

Several strategies have been adopted by households to deal with the many risks and shocks that lead to poverty. The most common coping mechanism of households is to reduce the number of meals. In fact, over 35% of the households reduce food consumption as a response commodity price shocks. Over 20% respond by seeking additional piecework and 10% respond by informal borrowing. It is also noted that poorer households, in addition to reducing consumption, are more likely to sell assets and pull their children out of school[26] (see NBS, 2004). These actions have negative consequences in the long-term.

The Federal Government has also made efforts in dealing with the problem of poverty in Nigeria. In an appraisal of poverty reduction strategies in Nigeria, Ogwumike (2000) notes that the poverty alleviation measures implemented so far have focused more on growth, basic needs and rural development approaches. Before the structural adjustment programme (SAP), the government focused on increasing the real income of the average citizen as well as reduce income inequality. To achieve these, the programmes designed (such as the Agricultural Development Programmes (ADP), the Agricultural Credit Guarantee Scheme (ACGS), Operation Feed the Nation (OFN), Green Revolution, and the Rural Banking Programme (RBP)) were geared towards employment generation, enhancing agricultural output and income, and stemming the tide of rural-urban migration. Some of these programmes failed as a result of diversion from the main focus.

A snap-shot of the anti-poverty programmes implemented by the government during the SAP era and period of guided deregulation (between 1986 and 2007) is presented in Table 2.12. It is noted that many of these programmes had varied impact on poverty alleviation. Some of the programmes impacted positively on target groups, and contributed to poverty reduction. However, as evidenced by the poverty profile of the country, the magnitude of impact can be considered as marginal and far from impressive. The reasons for the poor performance of these programmes can be attributed to a number of factors including lack of standards for project harmonization and effective mechanisms; inadequate funding to cope with needs of the ever increasing number of job applicants in the country (in the case National Directorate of

[26] Watts (1983) provides a detailed account of Hausa farmers' response to the early 1970s drought in Northern Nigeria. He argued that sales of livestock played a central role in the response to drought. As regards cutting back food consumption below adequate levels or dropping children out of school, see Ogunyankin and Omenka, 2012; Jacoby and Skoufias, 1997; Moser, 1998.

Employment); diversion of resources for personal enrichment, corruption, and gross mismanagement (in the case of Better Life Programme, and Community Banks); and, improper execution of projects (in the case of Family Support Programme and Family Economic Advancement Programme). Indeed, most of the poverty alleviation strategies were well focused; however, they failed to produce the desired results.

An indication that these measures were not successful was the introduction of the National Economic Empowerment and Development Strategy (NEEDS) towards the end of 2003 and NEEDS II, in 2007. The NEEDS aimed at poverty reduction, wealth creation, employment generation and value re-orientation through a variety of reforms, including macroeconomic stability, deregulation, liberalization, privatization, transparency, and accountability. To realize these objectives, some factors were identified as possible causes of the nation's poor economic goals, and obstacles to poverty reduction such as corruption, lack of due process for the award of government jobs and contracts, lack of proper monitoring of budget implementation, lack of accountability and conflict within civil society. Whether or not NEEDS II is able to achieve its core objective remains an open question.

Table 2.12. Anti-poverty programmes by the government of Nigeria

Programme	Year established	Target group	Nature of intervention
Directorate for Food, Roads and Infrastructures (DFRRI)	1986	Rural Areas	Feeder Roads, rural water supply and rural electrification
National Directorate of Employment (NDE)	1986	Unemployed youths	Training, finance and guidance.
Better Life Programme (BLP)	1987	Rural women	Self-help and rural development programmes, skill acquisition and health care
Community Banks	1990	Rural residents, micro enterprises in urban areas	Banking facilities
Family Support Programme (FSP)	1994	Families in rural areas	Health care delivery, child welfare, youth development, etc
Family Economic Advancement Programme (FEAP)	1997	Rural areas	Credit facilities to support the establishment of cottage industries
*National Economic Empowerment and Development Strategies (NEEDS I & II)	2003;2007	National	

Source: Oladeji and Abiola (1998)
* NEEDS I & II are included by the current author.

2.6 Concluding remarks

Agriculture and oil are linked to other sectors through flows of intermediate inputs and to the world economy through trade. The two sectors' outputs are used largely as an intermediate input by other sectors, and both also make use of input from other sectors. In particular, agriculture buys inputs such as chemicals, which are made using energy-intensive technologies.

The overview of the Nigerian economy reveals that agriculture has always played a key role in the nation's economy; however, growth in the sector has not kept pace with the needs and expectations of the nation. Even though at some point in time Nigeria was the world's largest exporter and significant producer of groundnuts, cocoa, palm oil, coconuts, citrus fruits, maize, pearl, millet, cassava, yams, and sugar cane, food production (since the discovery of oil) has not kept pace with population growth, resulting in rising food imports and declining levels of national food self-sufficiency. This has made the country susceptible to rising food prices in the global economy. The dominant role of the oil sector since the discovery of oil has pushed agriculture, the traditional mainstay of the economy, to the background. Consequently, the reliance of the Nigerian economy on the oil sector has also introduced large distortions into the economy which have had varied impact on households.

A number of policy measures and interventions have been implemented overtime to promote food security and domestic production of refined oil so as to reduce households' vulnerability to shocks in the international prices of food and refined oil. These measures have had varying effects on the domestic economy and households.

CHAPTER 3

LITERATURE REVIEW ON INTERNATIONAL COMMODITY PRICE SHOCKS AND HOUSEHOLDS

3.1 Introduction

In this chapter, I review extant theoretical, methodological and empirical literature on the subject matter. It should be noted that poverty effects has been captured in the review as it represents the overall macro-shock effects on households in an economy. The review is aimed at achieving the following objectives: (i) to highlight the theoretical approaches that have been employed in studying households effects of international commodity price shocks; (ii) to understand the weaknesses and strengths of the various methodological approaches adopted by previous studies in explaining the linkages and warranted conclusions about the effects of international commodity price shocks on households; and (iii) to understand the implication of different empirical techniques on analytical outcomes. These objectives are satisfied in Sections 3.2 to 3.4, respectively. Section 3.5 presents the concluding remarks.

3.2 Theoretical review

Theoretical explanation of the linkage between international commodity price shocks and households is a complex issue due to multiplicity of channels through which shocks are transmitted. Existing literature suggests two main channels: the short-run channel and the long-run channel.[27] The long-run channel works via economic growth, while the short-run channel works through changes in employment; prices (production, consumption, and wages); access to goods and services; composition and ownership of asset; and transfers and taxes, (see World Bank, 2003; Mallick, 2008; Agenor, 2005a).

[27] Traditionally there has been a dichotomy within macroeconomic theory between the economics of the short and long-run (Solow, 2005).

3.2.1 Long-run channel (Growth channel)

Neoclassical growth models depict economies that converge smoothly to steady-state growth paths. However, Ramey and Ramey (1995) demonstrated in a seminal contribution, the negative link between shocks and economic growth. Negative shocks and volatility induce uncertainty and make investment and liquidity constraints binding (Aizenman and Pinto, 2005). Such indirect effects of shocks may be particularly harmful in poor households with weak shock absorbers (see Loayza *et al*., 2007, Raddatz, 2007).

As noted by Auffret (2003), with the assumption of complete markets, agents could be able to trade risk through financial and insurance markets, thereby avoiding turning production or income volatility into consumption and investment volatility.[28] The implication is that shocks would have only transient effects on economic output. How these changes in output affect economic agents has also been explored in the literature. However, although growth theories have tended to discount the relevance of volatility and shocks for long run economic performance (Lecocq and Shalizi, 2007), it has been shown that shocks can affect households both directly, through consumption volatility (particularly disturbing for the poor who find it difficult to smooth consumption in the face of a negative income shock), and indirectly through its effects on economic growth (Loayza et al., 2007).

Tambunan (2005) notes that, economic growth can be an effective tool for reducing poverty provided that mechanisms exist to facilitate trickle-down of the benefits of economic growth. However, there is no general consensus on the mechanisms by which an improvement in general economic performance resulting from a positive income shocks trickles down to the poor (Agenor, 2004).[29] As a result, with the exception of a few studies (Tambunan, 2005; Agenor, 2001; Frankenberg *et al*., 2002), most studies exploring the growth approach end up examining the macroeconomic effects of shocks and not really household effects. Studies that, however, push further to examine the effects of price shocks on household have considered either or most of the short-run channels.

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[28] It is worth acknowledging that the efficiency of trading risk through financial and insurance markets is more or less a mirage for the poor in developing countries since they barely have access to the markets, if at all they are well-fuctioning.

[29] For instance, Ajakaiye and Adeyeye (2001) finds a paradox of growth without poverty reduction as they discover that while economic growth was positive, for the most part since the 1980s in Nigeria, poverty intensified.

3.2.2 Short-run channel

The short-run channels highlighted in literature via which international price shocks affects households include: labour market (income and employment), product market (relative prices), and financial market (access to credit) (Tiongson, *et al*., 2010). Others include composition and ownership of asset; and transfers and taxes, (World Bank, 2003; Mallick, 2008; Agenor, 2005a).

Labour markets play an important role in the transmission of international price shocks to households (Agenor, 2005a). A number of studies have shown how labour market react to shocks (see Blanchard and Wolfers, 2000; Bassanini and Duval, 2006; Porter and Vitek, 2008; Campos-Vazquez, 2010). These studies pointed out that unemployment and changing wages. With an adverse price shock, resources are reallocated to more profitable sectors and demand of labour in the non-profitable sectors may fall; lower employment and nominal wages (in the presence of downward rigidity of prices) may translate into a fall in real wages (Agenor, 2005a; Tiongson, *et al*., 2010), and hence demand for imports as well as consumption will fall.

In addition, depending on the labour market status of households, the effects of price shocks are likely to differ across households (Alem and Soderbom, 2011). Households whose nominal wages are fixed in the short term may be more affected than households whose nominal wages rise with inflation. Thus, changes in labour market status may be a source of heterogeneity in the effects too. While income and employment effects in the labour market resulting from international commodity price shocks provides implications for households, a central issue remains the extent to which shocks result in fluctuations in labour market earnings. The literature suggest that structural policy settings as well as institutional characteristics might intensify or mitigate the employment effects of shocks and make them more or less persistent (Blanchard and Wolfers, 2000; Bassanini and Duval, 2006; and Noy, 2009).

International commodity price shocks tend to distort domestic price signals (Agenor, 2005a). Positive shocks to international prices certainly represents a negative terms-of-trade shock for countries that are import-dependent; however, the extent to which international prices pass through to domestic markets depend on the degree of integration of the domestic economy to the world market as well as the presence of trade distortions or subsidies allowed to support economic sectors vulnerable to rising international prices. In the absence of trade distortions, price changes alter the profitability of productive sectors, and affect relative wages and employment levels. In the case of price shocks resulting from natural disaster, lower wages may be an incentive for the enterprise sector to increase its investment rate which may contribute to off-set or more than off-set capital losses in such sector (Lopez, 2009).

Besides altering the profitability of productive sectors, higher prices reduce the real income of households, thus leading to declining consumption. The consumption effect may, however, differ across different households of differing economic status. According to Alem and Soderbom (2011), if preferences are homothetic and all individuals face the same prices, the consumption ratio for any two goods is constant across rich and poor households at a given point in time. Poor households typically spend a relatively large share of their food budget on items like cereals, tubers, and pulses, a smaller share on meat, dairy products, and oils and fats, than do richer households. Domestic price rigidities, however, can expand or contract the effects that international price shocks have on households. If the price of a commodity is fixed (say, due to domestic price regulation) international price shocks leading to higher domestic prices may not affect its consumption.

Shocks can also be amplified through the financial market. A negative terms-of-trade shock can adversely affect bank liquidity by reducing demand for domestic deposits, thereby forcing banks to curb credit roll-over (IADB, 1995; and Hausmann, 1999) and limiting households' access to credit. Tiongson, *et al.*, (2010) noted that changes in wealth may directly lead to adjustments in the consumption behaviour of households or indirectly through the role of certain assets, such as property, as collateral that affects a household's ability to access credit. Mallick (2008) noted that the effects of shocks can be temporary if households have assets to sell or access to credit, otherwise these households can eventually be pushed below the poverty line. While insurance and credit markets are usually poorly developed in developing countries, households can still protect themselves against temporary income shocks by building up a sufficient buffer stock that they can tap into in difficult times (Behrman *et al.*, 1997; Lim and Townsend, 1998; and Rosenzweig and Wolpin, 1993). However, it is observed that shocks tend to affect poor households suggesting their limited ability to cope with such (Dercon, 2004; Skoufias and Quisumbing, 2005; Townsend, 1994).

Finally, the literature also emphasised the role of government transfers and taxes in the transmission of price shocks to households. If government revenue depends largely on the prices of primary traded commodities, shocks to the international price of these commodities can have strong impact on its income. Reductions in government transfers, and cuts in current spending on goods and services or capital spending (which have longer-run supply-side effects), increase household poverty, by reducing aggregate demand and the demand for labour (Fabiosa and Jensen, 2002; Agenor 2005a). Also, governments, based on political pressures, may cut taxes to alleviate sectors affected by price shocks (Lopez, 2009). A cut in tax rates on wages or profits increases private expenditure on consumption and investment, by increasing expected income and the net rate of return on capital (Agenor, 2004).

Most studies have examined households' effects of international commodity price shocks based on either one of the identified channels. This, however, limits the understanding of the household effects as it considers only the market directly affected by the shock; thus, the emphasis on the adoption of the general equilibrium theory. The theory, which dates back to the pioneering works of Leon Walras (1870s)[30], seeks to explain the behaviour of supply, demand and prices in a whole economy with several interacting markets. The theory is capable of capturing other constituents of the short-run channel including employment, prices, access to goods and services, composition and ownership of asset, and transfers and taxes.

Within the framework of general equilibrium theory, alternative formulations exist depending on the assumptions made about markets, and economic agents. The neoclassical theory of competitive markets is one of such formulations. Here, the properties of consumer and producer behaviours are derived from simple optimization problems. It assumes that consumers and producers take prices as given. For consumers prices are exogenously fixed, while producers in competitive markets cannot influence prices with their choices. The interdependence of markets (product and factor markets), makes it suitable to accounting for the employment, income, and consumption effects of shocks on households.

[30] The modern conception of general equilibrium is provided by a model developed jointly by Kenneth Arrow, Gerard Debreu, and Lionel W. McKenzie in the 1950s.

3.3 Methodological review

The literature is replete with different methodologies that have been applied to explain the households' effects of international commodity price shocks. These effects are observed to depend on a number of issues including the type of commodity and measurement of the price shock, the instrument used to capture household-level effects, as well as the estimation procedures. For ease of appreciation, these issues have been structured and discussed in the subsections below.

3.3.1 Measurement of price shocks

What price shocks should be simulated, and how should it be measured in terms of impact on households? The answers to these questions vary among studies, and the review show that to a large extent they depend on the research questions, data availability, as well as the overall context of the study. Discussed in this sub-section are measurements of oil and food price shocks.

(a) Oil price shock: Alternative definitions and measurement

Oil price shocks are predominantly defined and measured with respect to price fluctuations resulting from changes in either the demand- or supply-side of the international oil market (Hamilton, 2008; Wakeford, 2006). These changes have been traditionally traced to supply-side disruptions such as OPEC supply quotas, political upheavals in the oil-rich Middle East and activities of militant groups in the Niger Delta region of Nigeria. The shocks could be positive (a rise) or negative (a fall). Two issues are identified regarding the shocks: first is the magnitude of the price increase which can be quantified in *absolute terms* or as *percentage changes*; second is the timing of the shock, that is, the speed and persistence of the price increase. As regards the speed and persistence of the price increase, Huntington (2005) distinguishes two types of price increments which are gradual and sudden price increments. The latter, he noted, involved not only very rapid price increases but also novel price movements that have not been experienced recently.

Kilian (2007) identified three possibilities in the measure of oil price shocks. The first, which is a natural baseline hypothesis, is that firms and consumers respond proportionately to a percent change in oil prices irrespective of the magnitude of the change. Another hypothesis is that firms and consumers only respond to large shocks, while a third possibility is that consumers and firms respond only to changes in oil prices that are unprecedented in recent history. It is this third possibility that formed the bedrock for the net oil price increase (NOPI) measure of oil price shock proposed by Hamilton (1996, 2003), which is defined as the difference between the current price and the maximum price over the previous year or the previous three years. This measure was later formalised (as in equation 1) and extended by Edelstein and Kilian (2007a,b) and Engemann *et al.*, (2011), to include negative oil price shocks (as in equation 2).

$$\Delta x_t^{+} = max\left\{0,100 \text{ x } ln \frac{x_t}{max\{x_{t-1},\ldots,x_{t-4}\}}\right\} \quad (1)$$

$$\Delta x_t^{-} = min\left\{0,100 \text{ x } ln \frac{x_t}{min\{x_{t-1},\ldots,x_{t-4}\}}\right\} \quad (2)$$

The NOPI measure is one attempt to statistically transform oil prices to extract the exogenous component of oil prices. Kilian (2008a,b) however, contended that NOPI are not measures of exogenous oil price shocks because of the nature of weak instruments used by Hamilton. He suggested that oil price series must be treated as endogenous whether they have been transformed to NOPI or not. Thus, most of the approaches in empirical work on oil price shocks (which largely attributes changes in the price of oil to oil price shock) is noted to implicitly assumes that the price of oil can be changed while holding everything else constant (as would be the case if the price of oil were exogenous). This assumption which appears to be reasonable has been found not to hold up to investigation because while macroeconomic aggregates respond to changes in the price of oil, higher oil prices may as well be driven by global macroeconomic aggregates (see Killian, 2005; 2009).

Wu and Cavallo (2012) distinguished exogenous oil-supply shocks from endogenous oil-price fluctuations driven by changes in oil demand by utilising market-based information to measure oil price shocks. Their method combined narrative and quantitative approaches to develop a new measure of exogenous oil-price shocks that avoid endogeneity and predictability concerns – visible shortcomings of the NOPI measure. In their approach, they identified the events that have driven oil price movements from each trading day since 1984, and then captured the unpredictable component of oil price fluctuations on each day using an oil-price forecasting exercise at a daily frequency. Finally, they aggregated shock series corresponding to the identified exogenous event types to construct a single measure of exogenous oil price shocks. However, it should be noted that their approach to obtaining a more reliable definition and measures of oil price shocks was to find a measure that best works in a Vector Autoregression (VAR) context so as to provide better estimates on their macroeconomic effects[31].

Within the framework of general equilibrium modelling, most studies that have analysed the macroeconomic and household effects of oil price shocks used either arbitrary or near-actual absolute terms or percentage changes in the price of oil (see for example, McDonald and van Schoor (2005) simulated a 20% increase in the price of oil; Essama-Nssah *et al.*, (2007), a 125% increase; Fofana *et al.*, (2007), a sustained US $20 a barrel increase of oil price; and Ajakaiye and Fakiyesi (2009), a 12.2%, 51.2%, 63.4% and 69.5% decrease in the international price of oil). The shortcoming of simulating arbitrary rather than actual observed price changes is discussed in part (iii) of subsection (b).

(b) Food price shock: Measurement issues

As regards measurement of food price shocks, issues have been raised along the conceptual definition of food as well as the fact that the magnitude of the shock differ across food types. Should the definition comprise only major staples or other consumable food items? If the definition is holistic, how should the variation in the magnitude of food price increase across various food types be managed? In addressing these issues, studies have employed different methods. These methods and identified issues are discussed below.[32]

(i) Actual vector of observed price changes

This requires estimating the effect of the actual vector of observed price changes at some level of aggregation over a given period of time. For example, Robles *et al.*, (2008) and Busjeet *et al.*, (2008) simulated aggregate food and non-food price changes observed in some countries in Latin America. The motivation for this approach is to underscore the changes in welfare and poverty that are presumed to have taken place during the shock period, and to decompose the effects coming from different price

[31] Agenor (2001) is, however, one study that employed NOPI to examine whether output contractions associated with cyclical output fluctuations and economic shocks have an asymmetric effect on households.

[32] Some of the options discussed were raised in De Janvry and Sadoulet (2008).

changes. The approach, however, does not give a clear message on the role of the specific price shock because many other changes in prices may have occurred during the period.

(ii) Simulate a subset of price of interest

This option involves simulating the increase in only some key food prices of interest while keeping other food prices constant. Under this approach, some studies compute a food price index from selected internationally traded staples and domestic foods that are close substitutes, and then identify the shock from the price series. For instance, following a methodology developed by Deaton and Miller (1995), Combes *et al.*, (2011) computed a food price index and then identified the food price shocks using a forecast model of Collier and Dehn (2001). The latter noted that shocks are located by differencing each country's aggregate real commodity price index series (to make it stationary), removing predictably elements from the stationary process, and normalizing the residuals.[33] The residuals are normalised by subtracting their mean and dividing by their standard deviation. Food price shocks, thus, are the positive observations of the residuals.

Lora *et al.*, (2011) also constructed a measure of food price shocks. They first created a summary of international food prices. However, rather than use fixed weights like the IMF or FAO, they extracted the common movements in a set of food commodity prices (sugar, corn, wheat, soya, and rice). This was achieved using a Principal Component (PC) technique. Ivanic and Martin (2008), observed a vector of key international price increases from FAO statistics (beef 0%, dairy 90%, maize 80%, poultry 15%, rice 25%, sugar 0%, and wheat 70%), assuming all other prices constant.

A shortcoming of this approach as pointed by De Janvry and Sadoulet (2008) is that keeping other prices constant may exaggerate the relative movement of prices and hence the effects of the food price shock. This raises the question of what to assume for other prices if the approach is to simulate a subset of price. One way to overcome this as suggested by De Janvry and Sadoulet (2008) is to set all other goods to increase as the overall Consumer Price Index (CPI).

[33] It should be pointed out here that this approach was applied to a cross-country study and adaptable to an econometric estimation technique of panel data.

(iii) Simulating artificial price changes

Other studies have adopted the third option which is simply the use of artificial price increase (expressed in percentages) of specific commodities, keeping all other prices constant. The percentage increase did not, particularly, relate to the actual price increases observed in specific countries but serve to demonstrate the mechanism of transmission of key relative price increases to welfare. Examples include Wodon (2008) who considered a 25% and 50% increase in the prices of cereals (in all their sample countries), and milk, sugar, or oil and butter (in some countries); Coady *et al.*, (2006), a 33% increase in the price of rice; Dessus *et al.*, (2008), a 10%, 20%, and 30% increase in price for the food aggregate (for urban population); Ivanic and Martin (2008), 10% increase in the price of beef, maize, rice, dairy, poultry, sugar, and wheat, etc. These simulations serve the purpose of illustrating the mechanism of transmission of key relative price increases to welfare, but do not relate to the actual price increases observed in specific countries.

3.3.2 Alternative approaches to simulating household effects

A number approaches have been employed to estimate households effects of international commodity price shocks. The different estimation methods found in the literature can broadly be categorized into the: econometric model/partial equilibrium approach and general equilibrium modelling approach. The description of the methods as well as their relative strengths and weaknesses are discussed below. The essence is two-fold: to make a case for the choice of estimation technique adopted in this study, and to show the methodological value addition of this study.

(a) Econometric model / partial equilibrium approach

The partial equilibrium approach has been applied to both single- and cross-countries studies. Two ways in which this approach has been conducted include: measuring the effects of shocks on growth and then changes in growth on household welfare; or modelling household welfare/consumption c_i to depend on a type of price shock as well as other factors. The latter is a more direct approach. In this approach, some studies have used change in real income as a first order approximation to change in welfare[34] represented by Farm-Household Model (Kuroda and Yotopoulos, 1978; Singh *et al.*, 1986); Net Benefit Ratio (Deaton, 1989; Coady *et al.*, 2006; Wodon and

[34] This approach is theoretically founded on the concept similar to compensating variation – the money-metric loss in welfare due to changes in consumption prices and income.

Zaman, 2008; Ivanovic and Martin, 2008; and, De Janvry and Sadoulet, 2008); and the Envelope Model (Essama-Nssah, 2007).

(a.1) Farm-household model

Although first introduced by Kuroda and Yotopoulos (1978) to explain the counterintuitive empirical finding that an increase in the price of a staple food did not significantly raise the marketed surplus in the rural sector of Japan, the Farm-Household Model (hereafter, F-H model) – popularised by the classic work of Singh *et al.*, (1986) appears to be a convenient starting point for this review.[35] The model has evolved overtime to resolve the apparent paradox of a positive own-price elasticity of demand for food in farm households, as well as the puzzle of sluggish marketed-surplus responses to food-price changes.[36] The basic neoclassical household-farm model presented in Singh *et al.*, (1986), revealed some empirical evidence of a positive own-price elasticity of food demand. Since in the household-farm is both a consumer and producer of food, it is adversely affected by a higher food price as a consumer, but as producer, it profit from food production increases. If this profit effect outweighs the Slutsky effects on food demand, the household's demand for food increases with the food price. This higher food demand reduces the positive effect of food prices on the marketed surplus of food to urban households.

Although the F-H models offer insights into the likely impacts of price shocks under alternative market scenarios, questions have been raised on the basic assumptions of shared preferences and incomes underlying the models (see McElroy *et al.*, 1981). It has also been pointed out that the micro focus of F-H models overlooks an array of other linkage-effects on households besides production and consumption, neglects substitution effects, both in consumption and in production, as well as ignores general equilibrium effects of the price changes (Taylor and Adelman, 2003). Thus, a more holistic analysis needs to incorporate other indirect influences of food price shocks that are masked by F-H models.

(a.2) Net benefit ratio (NBR)

In a seminar piece, Deaton (1989) starting with the household living standard expressed as an indirect function of household income and prices, described the

[35] It should be noted that the F-H model was applied to the analysis of food price changes.

[36] It should be noted that while early uses were concerned primarily with farm price policy, the F-H model has been applied to diverse issues including off-farm labor supply, technology policy, nutrition policy, downstream growth, labor supply, migration, income distribution, savings and family planning (see Jacoby, 1993)

weighted sum of proportionate changes in prices as given in equation (3) below as net benefit ratio (NBR). Deaton postulated that the first-order welfare effect of food price changes on household welfare is proportional to the net benefit ratio - the difference between the consumption and production ratio.[37] He showed that the direct effect of small price changes on social welfare[38] can be estimated as:

$$\frac{\partial W}{\partial \ln p_k} = \sum_i \theta_i (x_i, z_i) \frac{p_k (y_{i,k} - q_{i,k})}{x_i} \qquad (3)$$

where W is social welfare, p_k is price of good *k*, θ_i captures the social value of transferring one unit of money to household *i*, x_i is total consumption expenditure in household *i*, z_i denotes characteristics of household *i*, $y_{i,k}$ is total amount of good *k* produced by household *i*, and $q_{i,k}$, is the amount of good *k* consumed by household *i*. Empirical applications is, however, based on the last term on the right-hand side of equation (3) which is net sales of each product divided by total household expenditure.[39] This is referred as the net benefit ratio.

This approach has been used by a number of studies to simulate the household effects of food price changes (De Janvry and Sadoulet, 2009 for India; Zezza *et al.*, 2008 for a cross-section of developing countries; Ivanic and Martin, 2008 for a sample of 10 countries; Wodon *et al.*, 2008 for a dozen West and Central African countries[40]; Wodon and Zaman, 2008 for Sub-Saharan Africa; Barret and Dorosh, 1996, and Coady *et al.*, 2006 for Madagascar; and Budd, 1993 for Cote d'Ivoire).

Building on Minot and Golleti (2000), Zezza et al., (2008) formalised the last term on the right-hand side of equation (3) as:

$$\frac{\Delta w_i}{x_{0i}} = \frac{\Delta p^p}{p_0^p} PR_i - \frac{\Delta p^c}{p_0^c} CR \qquad (4)$$

[37] The 'consumption ratio' is defined as the elasticity of the cost of living with respect to changes in price while the 'production ratio' is the elasticity of food sales to total household monetary income. These ratios are calculated using data from nationally representative household survey, which contains information on household incomes and expenditures.

[38] Deaton estimated a social welfare function on the intuition that welfare of different households will generally weigh differently in the government's objectives.

[39] Given the subjectivity involved in determining, it is not specified in applied analysis (see Deaton, 1989 for more discussion on this).

[40] In addition to the standard Deaton methodology where both consumers and producers face the same price increases, Wodon *et al.*, (2008) considered a variant of Deaton framework where only consumers are assumed to face this price increase.

This represents the immediate welfare effects of changes in price. Where Δw_i is the first-order approximation of the change in welfare for household *i* of a change in the staple food price, x_{0i} is the original income (proxied by total consumption expenditure) of household *i*, p_0^p is the original price of the staple at which production is valued, p_0^c is the original price of the staple at which consumption is valued, PR_i is the value of the production of this staple for household *i* as a proportion of x_{0i}, and CR_i is the value of the consumption of this same staple for household i as a proportion of x_{0i}.

To preserve flexibility in the functional form of this method, most studies use non-parametric regressions of the net benefit ratio on the natural logarithm of: household expenditure per capita (Deaton, 1989[41]; Budd, 1993[42]; Ivanic and Martin, 2008; Rios *et al.*, 2008; Zezza *et al.*, 2008; Wodon *et al.*, 2008); household income per capita (Barrett and Dorosh, 1996[43]); or household landholdings per capita (Barrett and Dorosh, 1996). Although, income can be used as a proxy for welfare, however, because of life-cycle considerations, most studies employ household per capita expenditure.

The advantage of nonparametric density estimation and kernel smoothing is their ability to accommodate the richness of household survey data while allowing convincing demonstration and presentation of results with a minimum of unnecessary assumption (Deaton, 1989). These techniques, however, do not allow for substitution on the part of producers or consumers (that is, production and consumption patterns remain unchanged).[44] As a result, the possibility of second order adjustments, such as shifts in consumption away from commodities with relatively large price increases, which should dampen any negative first-order impacts are ignored. The likely implication is an overestimation of the welfare loss in consumption, and an underestimation of the income gain in production (De Janvry and Sadoulet, 2008).

[41] Deaton employed kernel smoothing to show the nonparametric regressions of the rice share on the logarithm of household per capita expenditure graphically.

[42]Budd (1993) extended the works of Deaton to incorporate confidence bands using the asymptotic distribution of the estimator which he noted are crucial for evaluating the empirical results.

[43]Unlike Budd (1993), Barrett and Dorosh (1996) employed the bootstrapping technique on the confidence bands. This technique generates an empirical distribution of a parameter estimate through resampling.

[44] Minot and Goletti (2000) therefore describe this as a “before-response” effect.

To account for any behavioural change (second order adjustments) on the part of households in production and consumption decisions, the short-term own-price elasticity of food supply and the own-price Hicksian elasticity of food demand are added to the production and consumption side respectively, of equation (4) (see Minot and Golleti, 2000; Friedman and Levinsohn, 2002; and, Robles and Torero, 2010). This is done through a second-order Taylor expansions of the expenditure function. However, as pointed out by De Janvry and Sadoulet (2008), the substitution effects are generally small in comparison to the first-order effects that remain valid even in the medium term. This is because the method is only well-suited for infinitesimal price changes (De Janvry and Sadoulet, 2008; Essama-Nssah, 2007).

Although, estimation of equation (4) has been applied to cross-country analyses because it can account for regional variations in price changes within each country, and for different prices changes for different commodities, however, the loss of some degree of cross-country comparability is inevitable. To overcome this, some studies simulate an identical flat percentage increase in both producers and consumer prices for selected food (see for example, Zezza *et al.*, 2008). This, however, underestimates/overestimates the effects of the price shocks in some countries as the actual prices recorded on local markets may differ significantly.

(a.3) Envelope Model of Household Welfare[45]

The Envelope model of household welfare assumes that each household's preferences over commodities demanded and labour supplied to both external and own production activities can be represented by a utility function (Essama-Nssah, 2007). The household is also assumed to earn profit from a productive activity. The optimal behaviour of household *h*, given the level of resources and prevailing prices can be represented by an indirect utility function:

$$v_h\left(p_h^s, p_h^d, w_h\right) = \max_{q_h^s L_h}\left[u_h \middle| \left(q_h^d, L_h\right) p_h^d q_h^d = w_h L_h + \pi_h\left(p_h^s\right)\right] \qquad (5)$$

where, q_h^d represents a vector of commodities demanded by the household, L_h is the vector of labour supplies by activity, w_h is the corresponding vector of wages, p_h^d and p_h^s stand for vectors of consumption and production prices, respectively, while

[45] This model is similar in spirit with the NBR; only that it is has been largely applied to studies on oil price shocks. The model is based on the optimization ideas of Dixit (1990).

$\pi_h\left(p_h^s\right)$ is the maximum profit achievable from own production, given prevailing prices.

After normalizing the partial derivative[46] of the above function (equation 5) on the basis of the marginal utility of income, Essama-Nssah (2007) obtained and estimated an overall household welfare change induced by price changes resulting from an oil price shock on the South African economy, in the form:

$$g_h = \sum_{j=1}^{m}\left[p_{hj}^s q_{hj}^s \frac{dp_{hj}^s}{p_{hj}^s} - p_{hj}^d q_{hj}^d \frac{dp_{hj}^d}{p_{hj}^d} \right] + \sum_{i=1}^{n}\left[w_i L_{hi} \frac{dw_i}{w_i} \right] \qquad (6)$$

where g_h denotes gain to household, and other variables are as defined above. The equation (6) says that a first-order approximation of the welfare impact in a neighbourhood of the optimal behaviour of the household is equal to a weighted sum of proportionate changes in prices. A limitation of the envelope model approach is that it focuses solely on the welfare implications of price effects induced by shocks, assuming away any endowment and occupational effects. Bourguignon and Ferreira (2005) argues that, besides price effects (captured by the envelope model), the distributional impact of price shocks on economic welfare can have endowment effects due to changes in the amount of resources available to individuals, and occupational effects linked to changes in resource allocation. These effects can be captured by a model of earnings (see Essama-Nssah, 2007).

The major strength in econometric / partial equilibrium approach lies in its ability to provide formal measures of confidence of its results. However, most of the models have few variables and few equations, with most of them being linear. Consequently, as pointed out by Kraev and Akolgo (2005), they are not best suited for solving many simultaneous, nonlinear equations, and thus not appropriate for representing a disaggregated production structure and the many causal channels of transmission. In addition, Deaton (1989) noted that linear regressions tend to over-summarise the results obtained.

Besides the limitations of the specific partial equilibrium approaches discussed, they plainly ignore general equilibrium consequences of international price shocks on

[46] The first derivative is based on the envelope theorem - the change in the maximum utility induced by a change in one of its arguments is equal to the partial derivative of the indirect utility with respect to the argument (see also, Roy's Identity).

employment patterns, wages, domestic prices of other factors and products, and technological innovation. Accounting for these effects as well as their transmission mechanism requires modelling within a multi-market framework as in a computable general equilibrium (CGE) framework.

(b) General equilibrium modelling approach

The difficulty experienced in accounting for the general equilibrium consequences of price shocks as well as identifying the transmission mechanism in other empirical methods suggests that a counterfactual analysis within a general equilibrium framework provides an ideal experimental stage. General equilibrium models are economy-wide models which have strong theoretical underpinnings. Following the first general equilibrium model for a developing country by Adelman and Robinson (1978) for Korea, and Lysy and Taylor (1980) for Brazil, significant advances have been made to general equilibrium models. The literature is rich in alternative formulations of general equilibrium models some of which have been applied in Nigeria.[47] Among the general equilibrium model that have been developed so far,[48] CGE models remain the most widely used.[49]

CGE models are multi-sector models that provide a macroeconomic general equilibrium link among different activity sectors, economic agents, and external relations.[50] Unlike the methods employed within the partial equilibrium framework, these models incorporate a set of behavioural equations describing the economic behaviour of the agents identified in the model, and the technological and institutional constraints facing them. As a result, they have the advantage of responding to shocks, while fulfilling the optimality conditions of agents' behaviour, technological feasibility, and resource constraint. This subsection presents the variants of CGE models that have been applied in modelling the household effects of price shocks.

[47] See Adenikinju and AERC (2009) for a survey of the types and variants of CGE models including theoretical development in CGE modelling and a survey of CGE models applied in Nigeria.
[48] See Essama-Nssah (2005) for a comprehensive review of some of the modeling approaches that are in use in the evaluation of the impact of macroeconomic shocks and policies; and World Bank (2003) for summary information on a series of tools and methods available.
[49] Bandara (1991) provides a pretty comprehensive review of CGE models applied to developing countries; a substantial part of this review is concerned with macro issues.
[50] For definitions of CGE models see Dixon *et al.*, (1992), and Thissen (1998); and Dixon (2006) for distinguishing characteristics of CGE models.

(b.1) Static versus dynamic CGE models

Broadly, CGE models can be described as either static or dynamic. Static CGE models consider counterfactual equilibrium analysis based on the comparison of the base year values with changes brought about by the impact of a shock. Some of the static CGE models which have been employed in the study of shocks include the 123-PRSP model[51], Poverty Analysis Macroeconomic Simulator I (PAMS I) (Pereira da Silva *et al.*, 2003); PAMS II (Essama-Nssah, 2005), as well as other standard CGE models developed by institutions such as the International Food Policy Research Institute (IFPRI) and Partnership for Economic Policy (PEP) network.

The "123-PRSP Model" in Devarajan and Go (2003)[52] simplifies the CGE framework into an aggregative distinction of tradable and nontradable goods. The model generates a set of wages, sector-specific profits and relative prices that are mutually consistent for a given set of shocks or policies. The link with household is made when the model's projected changes in prices, wages and profits are plugged into household data on wages, profits and commodity demands for representative groups.

Another simulation framework analogous to the 123-PRSP is the PAMS. Its design contains three layers: the macroeconomic layer; mesolevel, based on the idea that each household in the economy gets its means of livelihood both from the government and from the market; and the microlayer which deals with household-level information linked to the meso framework. To compute the household effect, the per capita income or expenditure of the household is multiplied by the induced growth rate of the disposable income of the representative group to which the household belongs. A latter modification – a reduced form version of PAMS (PAMS II) derives the poverty outcome of shocks by linking recursively an appropriate disaggregated CGE model with a poverty and inequality estimator built upon a parameterization of the Lorenz curve (Essama-Nassah, 2005).

Although the various methods are distinguished by the level of sophistication and information retained in either the macroeconomic or microeconomic component, there is a drawback. It has been argued that static CGE models contained an analytical inconsistency. Being comparative static, the model does not take into account the adjustment path implied in each scenario nor the associated costs of adjustment. The

[51] The name stands for one country, two sectors and three commodities, and it is built into the macroeconomic framework for Poverty Reduction Strategy Papers (see Devarajan and Go 2003).
[52] See also Daza *et al.*, (2004)

implication is that the same producers and consumers who optimized their within-period decisions, such as allocating expenditures among commodities, stopped optimizing when it came to between-period decisions, such as savings and investment (see Bell and Srinivasan, 1984, Devarajan and Go, 1998).

This limitation stimulated the development of dynamic CGE models which accounts for the time path of adjustment to shocks or proposed policy changes (based on the premise that some shocks or policy changes require adjustment-time) (Chitiga and Adenikinju, 2009; Annabi *et al.*, 2007). Two approaches - the recursive and intertemporal dynamic CGE models, have been employed in CGE models to capture the time path of adjustment resulting from shocks.

(b.2) Recursive- and intertemporal- dynamic CGE models

Dynamic CGE models can be classified as sequential dynamic (recursive) or truly dynamic (intertemporal) models (Annabi *et al.*, 2007). The basic distinction between the two is in their treatment of the "dynamics" which draws from the assumption made about the behaviour of economic agents in relation to their foresight. Truly dynamic models assumes that economic agents are characterized by perfect foresight (an assumption that has been contested in the literature, especially in the context of developing countries where imperfect information is common-place; see Cockburn and Decaluwe, 2009). On the other hand, sequential dynamic CGE models which are basically a series of static CGE models with limited number of recursive links from one period to another assumes that economic agents are myopic (Cockburn and Decaluwe, 2009). This latter approach is, thus, widely used because of its practicability and appropriateness for analyses within the context of developing countries.

There has been a growing development in the application of both standard recursive-dynamic CGE models (see for instance, Laursen *et al.*, 2004; Annabi, *et al.*, 2007; Morley *et al.*, 2011; Decaluwe *et al.*, 2012 - a modified version of 2010), and intertemporal CGE models such as the 123t model (a truly dynamic version of the 123PRSP static model) to the study of a wide range of macro shocks and policies issues.[53] However, irrespective of the type of the CGE model (that is, whether static or dynamic) it provides richer information on the household effects of shocks because of its treatment of households.

[53] The Integrated Macroeconomic Framework for Poverty Analysis (see Devarajan and Go, 1998; Agenor, 2003; Agenor *et al*., 2003, 2005a) is among the class of CGE models developed so far.

(b.3) Representative households versus microsimulation CGE models

One of the strengths of the CGE model over the econometric methods as well as other general equilibrium models is its ability to incorporate detailed information on how households earn and spend their incomes. Two ways this has been done is to make use of representative households (RH, hereafter) (see Lofgren *et al.,* 2004) or microsimulaton[54] (an approach that makes use of more dissaggregated households data from nationally representative household surveys) (see Decaluwe *et al.,* 1999; Cogneau and Robillard, 2000; and Cockburn, 2001). Although, the RH approach is based on very strong theoretical assumption[55] it has been argued that its inability to capture households' heterogeneity or intra group income distributions limits its analytical power on the poverty impacts of external shocks; [56] thus, the increasing emphasis on microsimulation CGE models.

The microsimulation CGE models, starting with Cogneau (1999), combine CGE models with micro data provided by household surveys. They are applied in two distinct ways: layered or integrated approach. The layered approach first solves the CGE model to capture price, exchange rate, and macro changes; and then combines the results generated with microsimulation information from household surveys (see Bourguignon *et al.*, 2003, Hérault, 2005; and, Bussolo and Lay, 2003). This is commonly referred to as the top-bottom approach. The second approach, on the other hand, integrates each individual household directly into the CGE; hence, its name: integrated microsimulation CGE model (see Cogneau and Robilliard, 2000; Cockburn, 2001; Bussolo and Round, 2003; Ferreira *et al.*, 2003; and, Cororaton and Cockburn, 2007).

The strength of CGE microsimulation over RH approach lies in its treatment of heterogeneity which is quite explicit in terms of consumption preferences (Vaquar and Cathal, 2007). However, some issues have been raised along the line of model specification and data reconciliation in a fully integrated microsimulation-CGE mdoel (see Bourguignon *et al.*, 2003, for instance), and feedback effects from the household level analysis (see Savard, 2003).

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[54] The idea of microsimulation dates back to Orcutt (1957) but it was not until the late 1990s that it was used for analysis of macro-poverty linkages

[55] An exogeneity assumption about the within-RH income distribution is made so as to compute poverty indices. Thus, the within-RHG income distribution has to be held fixed unless another assumption can be made regarding the way it varies.

[56] See Cockburn and Decaluwe (2009) for a discussion on this.

(b.4) Macro closures[57]

There has been much discussion in the CGE modeling literature about treatment of market equilibrium (that is, closure rules) for the models. As noted by Thissen (1998), this discussion was revived by Lysy and Taylor (1980) who found that the choice of macro-closure to a large extent affects the policy simulation results obtained with a CGE model. This draws from the evidence that the choice of a closure determines the direction of causality in a model (Gilbert, 2012). Given the importance of the closure rule for results obtained in the model, CGE models are often classified by their respective closure. Broadly, they are: Walrasian system (in which markets clear) with neoclassical saving-driven features, and structuralist model (which emphasize structural rigidities in markets and institutions) with macro CGE closures that dismiss many of the neoclassical postulates (see Ezaki, 2006).

CGE models include three major macro balances vis-à-vis government balance, external balance, and savings-investment balance (Lofgren *et al*., 2004). In empirical studies, a number of closure rules have been applied to attain macroeconomic balance in CGE models.[58] For savings-investment balance, the neoclassical closure rule, which is fundamental to Walrasian CGE models, is saving-driven. This rule assumes the existence of a mechanism that equilibrates investment with savings at a level that guarantees full employment in the economy. Thus, aggregate investment is determined by aggregate savings, which in turn are determined endogenously through fixed savings rate out of after-tax income and government deficit.

Alternatively, there are three non-neoclassical macro closures. The first, Keynesian-Johansen closure, assumes no full employment. Consumption function is excluded from the system; rather, government variable (tax or spending) will equilibrate saving and investment (Johansen, 1960). The second, Kaldorian-Pasinetti closure does not support the marginal productivity condition. Thus, wages are either sticky or fixed. The Kaleckian-Taylor closure, which is the third, is often used in structuralist models (Taylor, 1990). It assumes the existence of excess capacity; thus, production is fixed. It also assumes the presence of oligopolistic markets, thus, prices consist of some mark-ups.

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[57] A macro closure determines how macro-equilibrium is reached after a shock.

[58] See Thissen (1998) for a more discussion on some of the closure rules.

Despite the debate in the literature about the appropriate choice of closure, Thissen (1998), and Decaluwe, *et al.,* (2000) emphasized that the choice of a closure rule should be determined by the personal theoretical preferences of the model builder and the empirically most plausible adjustment processes. Although, as noted by Decaluwe and Monette (1988), there is no rigorous criterion for choosing the 'right' macro-closure besides the modeller's intimate conviction of how the economy functions, considerations should be given to the specific nature of the problem and the shock of interest variable.

3.3.3 Measurement of shocks adopted and choice of methodology

To better understand and appreciate the choice of food price shock measurement adopted for this study, it would be worthwhile to provide a definition of food. The definition of food as used in this study tries to link to the international trade and agricultural policy dimensions of food. However, rather than focus on individual food crops, a set of major staples (rice, wheat, maize, sorghum, millet, and cassava, in particular)[59] is utilized because focusing on individual crops may be less meaningful in this study's context due to possibilities of substitutability among different food commodities in households consumption.

Based on this definition, the option which involves simulating a subset of price of interest is employed. However, unlike other studies (as discussed in subsection ii of section 3.2.1 above) that adopted this approach in partial equilibrium analysis, this study utilized it in a general equilibrium framework. Another point of departure besides its use in a general equilibrium setting is that the choice of food staples (used in the defining the subset) represents the main staples in Nigeria and simulation is based on actual prices changes between 2006 and 2008, thus, reflecting a close approximate of Nigeria's experience. This approach is also a deviation from the simulation of artificial price increase mostly employed in general equilibrium analysis as discussed above (in subsection iii of section 3.2.1).

Two assumptions are implicit in this approach: the constancy of other food prices; and that the international prices for the main staples foods are almost fully transmitted to the domestic market. While the first assumption allows for computational ease while reflecting the fact that not all food prices increased (at least, by the same magnitude)

[59] These commodities which are the main staples in the country – Nigeria, constitute part of what is considered the most part of foods imports around the world (see FAO, 2011).

between 2006 and 2008, the second assumption is valid for this study given the country's degree of international integration via trade. To neutralize the other idiosyncratic price movements, all other food prices have been set to increase as the overall CPI. It is worthy of mention however, that these assumptions have implications for the analysis, and as such, the results obtained in this study have been interpreted with some caution.

In measuring oil price shocks, actual percentage changes in the international price of oil between the base year (2006) and another referenced year (2008) is adopted. Despite arguments in the literature on the inability of this approach to truly reflect exogeneity in oil price, it is still employed in this study because, as Kilian (2009) argued, lack of exogeneity of the price of oil is not really a challenge in estimating the economic and households' effects of oil price shocks.

As regards methodological choice, this study employs the Representative Household approach in a recursive-dynamic CGE framework based on the following reasons: (i) unlike partial equilibrium models, CGE models are better suited tracing the effects of relative price changes on household incomes and expenditures (see Dorosh, 1996) since the shocks affecting one part of the economy may have substantial ripple effects on other parts of the economy; (ii) CGE models has both conceptual and accounting consistency; (iii) unlike static CGE models, the recursive-dynamic CGE model is capable of capturing changes in the behaviours of economics agents resulting from the effects of macro shocks and policies (Essamah, 2005); and (iv) the study's focus is not necessarily on intra-household effects.

3.4 Empirical review

Debate continues on the extent to which households are affected by international commodity price shocks as empirical studies have yielded different results. The variance in results can be attributed to the method adopted or the context in which the studies were carried out. Nevertheless, three important observations from the review are note-worthy. First, is that the effects of shocks depend on a number of factors including the size of the shock (both in terms of the percentage increase and the real price, the shock's persistence and the policy response of fiscal authorities such as trade distortions/subsidies. Second, is the evidence that poorer households and those with the fewest means to cope are affected more irrespective of the type of shock, country, region, or area (urban/rural) where they live in. Third, is the fact that methodological differences play a significant role in analytical outcomes of the impact of price shocks. This section presents the main arguments and findings in the literature on the household effects of international commodity price shocks. For ease of appreciation the review is done based on the major categories of shocks starting with the shocks of analytical interest (price shocks).

3.4.1 Oil price shocks

As discussed in the theoretical literature review section, rising international prices represents a negative terms-of-trade shock for countries that are import-dependent. The pass-through effect is noted to depend on the degree of integration of the domestic economy to the world market as well as certain interventions in the form of subsidies allowed to support economic sectors vulnerable to rising international prices.

The empirical literature on the impacts of oil shocks has evolved over the years since the 1970s. Until recently, the virtual obsession was to analyze the macroeconomic consequences of oil price shocks using different models and theories. Current research has shifted attention beyond the macroeconomic impacts to consider microeconomic implications, such as household effects - a review and discussion of which is presented in this sub-section.[60]

Pradhan and Sahoo (2000) constructed a 23-sectors, 3-factors and 9-households categories CGE model to analyse the impact of international oil price shock on the welfare and poverty of households in India. They found that household welfare declined and poverty increased following a 40% increase in international crude oil price. An increase in the elasticity of substitution of demand for imports to domestically produced crude oil increased the welfare loss for households groups.

Bacon (2005) found that for 97 net oil-importing countries (aggregated by per capita income ranges), a sustained US$10 a barrel price increase (equivalent to a 42.5% increase between 1999 and 2001) would deliver a shock equivalent to a loss of 1.47% of the GDP for the poorest countries (those with GDP per capita of less than US$300) while the highest income group (over US$9000 per capita GDP) would suffer a loss of 0.44% of GDP. On the other hand, net exporters experience a substantial improvement in the balance of payments as a result of higher oil prices. Also, the lowest income

[60] I have limited the empirical review of oil price shocks to studies that went beyond macroeconomic effects to consider households implications. For an excellent review and discussions of the macroeconomic impacts of oil price shocks, see: Jones and Leiby, 1996; Jones *et al.*, 2004; and Blanchard and Gali, 2008.

group (less than US$900 per capita income) would enjoy a 5.21% improvement in GDP. It was noted that within the income groupings there was variation between the oil exporters. For example, Angola, with net exports of oil at 70% of GDP, receives a positive shock of about 30% of GDP from a US$10 a barrel increase in oil prices. Other countries with very large impacts include Nigeria (18%), Republic of Congo (26%), Equatorial Guinea (36%), Gabon (21%) and Oman (17%). For households, they found that those within low-income decile were more severely affected than higher income groups but that in countries where petroleum products are subsidized, the impact of higher oil prices is not directly felt by households but indirectly through the worsening of government's fiscal position.

McDonald and van Schoor (2005), using a representative CGE model for South Africa, find that a 20% oil price increase (under the assumption that government expenditure adjusts to maintain budget balance) in the economy results in a 1% drop in GDP. Also, unskilled, skilled, and capital labour income declined by 0.6%, 0.9%, and 1.1% respectively. Consequently, rural households have a slightly smaller decline in incomes than their urban counterparts (-0.76% versus -0.83%). It was noted that the choice of factor market closure had significant effect on the result; allowing scarce capital mobility would generate a small additional welfare loss.

Using an input-output approach, Kpodar (2006) assessed the distributional effects of a rise in various petroleum price changes on the real income of households in Mali. In the study, no distinction was made between traded and non-traded sectors, and the level of consumption was constant with no provision for substitution. The result showed that, although rising gasoline and diesel prices mainly affected non-poor households, rising kerosene prices were most harmful to the poor. A 34% rise in the prices of all oil products decreased real income for the bottom quintile by 0.9%, while the income of households in the top quintile dropped by 1%. Between rural and urban areas, the study found that a 34% rise in oil prices increased the averaged expenditure of urban households by 0.98% compared with 0.8% for rural households. However, regardless of the oil product considered, he found that high-income households would benefit disproportionately from oil price subsidies; thus, suggesting that a petroleum price subsidy is an ineffective mechanism for protecting the income of poor households compared with a targeted subsidy.

In another study for South Africa, Essama-Nssah *et al*., (2007) employed a microsimulation model linked to the CGE model (in a recursive manner) and calibrated to a 2003 SAM to simulate the effects of rising crude oil prices. They found that a 125% increase in the prices of crude oil and petroleum products depreciates the exchange rate causing an increase in export earnings to enable crude oil importation and subsequent reduction in the real GDP by about 2%. With respect to their closure rule, they found, unlike, McDonald and van Schoor (2005), that under the assumption that scarce factors, and immobility of skilled workers and capital, unskilled workers benefits more from the crude oil price shock than skilled workers, and rural households than the urban households. However, in both studies, the less traded sectors did not benefit from the currency depreciation, thereby leading a relatively large fall in their output.

Using an input-output model combined with a household survey for South Africa, Fofana *et al*., (2007) found that a sustained US $20 a barrel increase of oil price, assuming a zero price elasticity of oil and oil products demand, reduces GDP by 0.2% in South Africa. The increase in domestic petroleum-products prices resulting from the shock are translated into an increase in the oil input cost especially for high intensive oil input industries. Poor households in rural areas and among the "black" population witnessed an increase in their cost of living compared to their corresponding highest expenditure quintile groups. However, an increase in transport fuel (gasoline and diesel) had more adverse effects on richer households than poorer households. In contrast to McDonald and van Schoor (2005) and Essama-Nssah *et al*. (2007), the direct impacts of high oil price on the South African economy as pointed out by Fofana *et al*. (2007) appears to account for a smaller part of the total (direct and indirect) impacts of high oil prices.

For Nigeria, Ajakaiye and Fakiyesi (2009) confirmed *a priori* expectations on the impact of negative oil price shocks on macroeconomic variables and poverty/household welfare in Nigeria. They found that oil price shocks slowed down the rates of economic growth. With the shock simulation scenarios under 12.2%, 51.2%, 63.4% and 69.5%, GDP deteriorated cumulatively by 0.96%, 4.3%, 5.43% and 6.02%, respectively, on average for the period August-December 2008, January-June 2009, July-December 2009 and 2010, respectively. Government income fell by 2.09% and 8.59% for the period August-December 2008 and January-June 2009, respectively.

In addition, the results showed an overall decrease in household income in Nigeria, increasing the level of poverty and worsening household welfare. For instance, in 2008, a 12.2% adverse oil shock affects the income of Nigerian households by 0.93% on average. Generally, relative to the reference period (January – July, 2008), they found that household incomes on average would fall by 5.07% in July-December 2009 under the cumulative 63.5% oil shock scenario. It would decrease by 5.60% in 2010 if the oil shock is represented by a 69.5% increase over the base period. Finally, a decrease in oil price had negative impacts in both the short and medium term on household purchasing power. From their simulations, they expected a further decline in household welfare in 2010.

Although the study by Ajakaiye and Fakiyesi (2009) provided interesting insights to the macro and distributive impacts of the recent oil price increases, they did not account for petroleum subsidy in their analysis. This shortcoming overestimates the impact of a fall in the international price of export on government revenue. Although with a negative shock to the international price of oil export, government's revenue from crude oil export would necessarily reduce, but since crude oil is a major industrial input in the production of refined petroleum, there would therefore, be a fall in the international price of refined petroleum *ceteris paribus*. This has implication on the amount of subsidy borne by the government for domestic consumption of refined petroleum. This net effect on government revenue was not captured in their analysis. As result the effect on government revenue and households would have been overestimated. This study overcomes this shortcoming by explicitly accounting for subsidy on refined petroleum in the CGE model.

3.4.2 Food price shocks

Efforts made to study the effects of rises in global food prices have been carried out at different levels – individual country studies as well as cross-country simulations[61]. These have met varying conclusions on the reasons behind the global food price increase (see Headey and Fan, 2008 for a comprehensive review) but somewhat similar conclusions on the implications of the shock on households. Some studies argued that lower food prices are advantageous to the poor, and thus, higher food prices will

[61] Heady and Fan (2008) notes that the cross-country poverty simulations carried out so far are empirically useful for identifying vulnerability to price changes across countries and subnational groups (e.g rural and urban). They provide evidence on the effect of price changes on poverty headcounts – the incidence of poverty changes as well as poverty gaps – the extent of poverty changes.

generally adversely affect poor households in developing countries because most of the poor households in developing countries are net food buyers, even in rural areas. Some others argued that the average impact of higher food prices depends on the balance between net food producers and consumers.

Ravallion (1989) found that low-income households are disproportionately affected by food price shocks from his study of a simulated staple food price spike in Bangladesh. He obtained large short-run losses for rural low-income households after a 10% increase in grain prices. He pointed out that the long-run effects would vary amongst the poor – with the poorest households gaining from price increases.

It has also been shown that the extent to which households are affected by rising international prices depend on the degree of trade distortions or subsidies allowed to support economic sectors vulnerable to rising international prices. Valero-Gil and Valero (2008) studied the effect of the food price increases of 2006-2007 on Mexican households using a first-order welfare measure.[62] They find after taking into account two policy measures - subsidies to the extremely poor and reduction of tariffs on some agricultural products (taken by the government in 2008 to reduce the impact of the shock) that the policies reduced, though *marginally*, the full impact of the shock. Specifically, they find that poverty rate (measured through consumption) increased from 25% to 26.48% and extreme poverty from 10.58% to 11.57%. With no trade distortion, they find that poverty rate increased to 27.83%, while extreme poverty increased to 12.11%. The partial equilibrium framework they applied considered only the direct impact that a changing food price will have on household expenditure, thus, excluding possibility of changes in other factors such as wages, and inflation of non-food products. This was based on the assumption of no substitution of food products upon price change given that the possibility of making substitutions between food products is small when all food prices rise.

Wood *et al.*, (2009), however, allowed for substitution within consumer food budgets in another study on the welfare effects of the recent staple food price increases on Mexican household, thus, extending McKenzie (2002) substitution findings and providing more accurate estimate of the welfare effects of food price increases on low income household than Valero-Gil and Valero (2008). Their results indicate that the

[62] First-order welfare measure here, is the difference in food expenditure under two price regimes assuming fixed quantities.

food price increases caused poor households to lose 18% of their food budgets' on average. They noted that substitution enables households with substitution options to recover a significant portion of the food budget; however, poor households could not regain income lost from food price increases. Also, they noted that the first-order welfare measures significantly overestimated economic welfare changes for some commodities, especially for non-poor households.

It has further been argued that since increases in food prices raise the real incomes of those selling food, many of whom are relatively poor, while hurting net food consumers, many of whom are also relatively poor, the average impact on poverty depends on *the balance between the two effects* (Deaton, 1989). For instance, Vu and Glewwe (2010) find that in Vietnam, the average welfare loss of the households whose welfare declines (net buyers) is smaller than the average welfare gain of the households whose welfare increases (net sellers). Consequently, the net impact of positive shocks to food prices on the welfare of an average Vietnamese household is positive. This was on the assumption that consumer and producer prices increased at the same rate. If consumer prices rise faster than producer prices, the positive impacts of higher prices on welfare and poverty reduction are smaller. Finally, they observed that when food prices increase moderately, rural poverty falls significantly while urban poverty rises mildly, and the net effect is a lower national poverty rate. But when food prices increase dramatically, urban poverty rises sharply, raising the national poverty rate.

In a study of Uganda, Benson *et al.*, (2008) find that in the short run, urban and rural net buyers are likely to be equally affected by high food price increase; however, in the medium term rural net buyers have an advantage since they are able to make some adjustments in their level of production and change the balance of their purchasing compared with food producing. The urban poor were found to suffer more from the rising food price crisis; thus, they suggested that the urban poor be singled out for close monitoring of their food and nutrition security status and trends in general welfare.

Ardnt *et al.*, (2008) find that urban households in Mozambique were more vulnerable to food price increases as urban poverty was estimated to rise by 8% following shocks to food and fuel. However, unlike Uganda, rural net seller households were likely to benefit from the rising food prices, particularly those in the middle income distribution. Rural wages were seen to rise relatively to urban wages. It was observed that higher fuel prices are likely to have greater impact on poverty than higher food prices, and that stimulating effect of improved agricultural terms-of-trade for the rural economy does not outweigh the negative impacts of the oil shock. In a combined simulation, they find that welfare declined for all households.

The effects are somewhat different for Pakistan as Chaudhry and Chaudhry (2008) find that the impact of food price shock on Pakistani poverty levels is substantially higher for households in the rural area than urban households. Their result showed that a 10% increase in food prices pushed up the rural and urban poverty headcount by almost 5% and 2.4% respectively, while a 20% increase in food prices pushed the rural and urban poverty headcount by about 9.6% and 5.1% respectively. It was acknowledged that the substantial difference between the two sectors was derived without taking into account the higher incomes that rural producers might earn due to the food price increases. This was based on their short-term analysis which assumed that increases in agricultural commodity prices will not be fully reflected in increases in the income of all related segments of society because incomes are more 'sticky' that commodity prices. In their analysis, just like Valero-Gil and Valero (2008), they did not allow for the possibility of low-income households altering their consumption patterns due to price changes, on the argument that substitution between commodities within household budgets for households at or below the poverty line is usually difficult. Also, unlike in Mozambique, it was found that the impact of food price increases on poverty levels in Pakistan is substantially greater than that of oil.

In Nigeria, Nkang *et al.*, (2013) find that with a 50% rise in the price of food imports GDP declined by 1.5%, while aggregate household income fell by 1.6%. Also, the shock depleted total savings and aggregate government income by a remarkable 4.5% and 15%, respectively. At the sectoral level, the shock led to an increase in domestic food production by approximately 5.2% while the output of other agriculture sector fell by 1.1%. They also found that factor demand in the food sector increased relative to other agriculture as well as the other sectors of the economy. Specifically, capital demand in the food sector went up by 3.7% while labour demand rose by 6.2%. In other sectors, both capital and labour demand declined as there was a shift of these factor inputs from other sectors of the economy to the food sector. At the household level, they find that the shock caused households disposable incomes and consumption expenditures to fall. Households' disposable income in rural-south and rural-north declined by 1.6% an 1.3% respectively; it declined by 1.7% and 1.9% for urban-south and urban-north, respectively.

Ivanic and Martin (2008) using household data for ten observations on nine low-income countries provided further evidence that the short-run impacts of higher food prices on poverty differ considerably not only by country but by sectors. For instance, in two of the three African countries surveyed they find that rural poverty increased more than urban poverty. For Malawi and Zambia, they find that the most influential commodity is maize and since both urban and rural households are net buyers, an increase in its price by 10% raises rural poverty in Malawi and Zambia by 0.5% and 0.8% respectively and urban poverty by 0.3% and 0.2% respectively. Also, a 10% increase in the prices of all staples increased rural poverty by 0.6% and 1.1% and urban poverty by 0.4% and 0.6% in Malawi and Zambia respectively. For Pakistan they find, contrary to Chaudhry and Chaudhry (2008), that increases in the prices of some food commodities lowered poverty in rural areas while raising it in urban areas. However, increase in urban poverty outweighed the lowered poverty level in the rural area, thus generating an increase of 0.3% in the national poverty rate.

In Vietnam, however, reductions in rural poverty were large enough to reduce overall poverty even though urban poverty rates increased slightly. Also, they find in Vietnam, that both in 1998 and 2004 the largest single commodity impact was through the price of rice. A 10% increase in price reduced rural poverty by 0.8% in 1998 and 1.0% in 2004; however, urban poverty rose by 0.2% in each case, while national poverty rate declined by 0.5% and 0.7% using 1998 and 2004 data respectively. In addition, they find that out of the nine countries, a 10% increase in the prices of all goods would reduce the poverty gap only in Peru and Vietnam. However, with the inclusion of wage impacts, poverty gap would increase for the sample of countries as a whole, by an average of 0.3% in rural areas, 0.2% in urban areas, and by 0.2% overall.

Wodon *et al.*, (2008) find in their sample of 12 West African countries that food price increases led to an increase in poverty because the consumption effects dominated the production effects. Also, with the exception of three countries – Ghana, Senegal, and Liberia, the poverty impacts of increases in food price are larger in percentage points in urban than in rural areas. In Ghana, they noted that poverty was low in urban areas in comparison with other countries while in Senegal and Liberia they observed that a large share of food consumed in both countries were imported. In general, they find that a large share of the increase in poverty led to deeper levels of poverty among households who are already poor.

In a cross-section of developing countries, Zezza *et al.,* (2008) find that in the short-term, poorer households and households with limited asset endowments and access to agricultural inputs were the hardest hit by price shock. For instance, in Panama the losses were consistently larger for the landless than for landowners. In Bangladesh, the welfare losses for the landless were as high as 3.6% in the bottom quintile. In rural Vietnam (where gains are estimated to accrue to a large share of the rural population), the landless were expected to incur an average loss of 1.7% with a peak of 3.3% in the bottom fifth of the expenditure distribution. Hence, in their survey, they find a clear positive and direct relationship between the amounts of land to which households have access to and the magnitude of their gain or loss from increased food prices. Furthermore, they find that in Bangladesh, Nepal, Pakistan and Vietnam, households that specialized in agriculture stood to gain substantially from higher food prices, with benefits accruing even to some poor households. In relation to gender of the household head, with the exception of Pakistan, they find that female-headed households (especially rural households) suffer a larger proportional drop in welfare due to increase in food prices than male-headed households.[63]

On a global level analysis, DeHoyos and Medvedev (2009) provided a formal the assessments of direct and indirect welfare effects of food price shock on poor households using a representative sample of sixty-three to ninety-three per cent of the population in developing world. They find that increase in food price between 2005 and 2007 led to increase in extreme poverty headcount at the global level by 1.7% but with significant regional variations – nearly all of the increase in extreme poverty occured in South Asia and Sub-Saharan Africa (SSA). With an increase in the headcount ratio of 6.34%, East Asia was, by far, the region that experienced the largest increase in poverty (especially urban poverty). Middle East and North Africa also experienced a relatively large increase in urban poverty due to sharp increase in the relative prices of food in these regions. In SSA, higher food prices did not translate into a significantly higher poverty rate for rural households. This was due to the

[63] The reason could be because in Pakistan, female-headed households represent a larger proportion of the wealthier income groups.

importance of self-employed agricultural incomes. For the second-order effects they find that a 5.5% increase in agricultural prices could raise global extreme poverty in 2010 by 0.6%.

The view that low-income households in developing countries are particularly harmed by higher food prices was challenged by Aksoy and Isik-Dikmelik (2008). Using household survey data from nine low-income countries, they find that only three of the nine countries revealed a substantial proportion of vulnerable households. Also, they find that net food sellers were disproportionately represented among the poor, thus, suggesting that food prices increases would transfer income from richer households (higher income net food buyers) to poorer households (net food sellers). Other factors that are potentially important in the analysis of food shocks, such as short term labour market effects (analyzed for instance by Ivanic and Martin, 2008), additional longer run supply response and general equilibrium effects were not calculated. In that sense, the household effect estimated represented the impact before any adjustment could take place in household production and consumption patterns.

Robles and Torero (2010) investigated the effect of the 2007-2008 “food crisis” on four Latin American countries: Guatemala, Honduras, Nicaragua and Peru. Like Friedman and Levinsohn (2002), they estimated a second-order Taylor expansion of the household net expenditure function around initial prices. They classified food commodities into six groups, and found much smaller welfare effects than Friedman and Levinsohn found for Indonesia. The average national compensating variations were of the order of 1.5% to 2.5% of initial expenditure in Guatemala, Honduras and Peru, and 7% in Nicaragua. In every country, the effects were somewhat larger in urban than in rural areas. They were also systematically regressive, with the compensating variation falling across income quintiles as income rose. On average, substitution effects (that is, allowing for the second term in the Taylor expansion) were rather muted: 2.3% of the direct effect in Nicaragua, 3.5% in Peru, 7% in Honduras, and 12.5% in Guatemala.

3.4.3 Fiscal policy response (Energy subsidy reform)

Fiscal policy encompasses a wide variety of policies comprising an endless list of types of incomes, for which the tax rules could be changed, or categories of government spending, where changes could occur (Mountford and Uhlig, 2005). The review here, however, focuses on a category of government spending – subsidy on petroleum. It should be noted that this subsidy is represents a direct payment made by government for consumption of refined petroleum or monetary loss incurred by the government for fixing domestic price of petroleum below the market price.

A few studies (Birol *et al.,* 1995; Hope and Singh, 1995; IEA, 1999) have used partial equilibrium models to analyse the impact of energy subsidy reform. These models consider only the market directly impacted by the subsidy reform, and estimates price, output and demand changes in that market. Von Moltke *et al.,* (2004) noted that the magnitude of these changes is determined by the price elasticities of supply and demand. Intuitively, with the rise in price (due to the removal of energy subsidy), demand will *likely* fall, resulting in a decrease in consumption and a loss of consumer welfare. Although, capable of providing useful insights into the impacts of subsidy reform, but as earlier discussed, partial equilibrium models are unable to address questions relating to inter-sectoral linkages[64] as well as macroeconomic questions relating to international competitiveness (UNEP, 2004; Ellis, 2010).

The variants of CGE models that have been used to analyse the impact of energy subsidy reform include multi-region CGE models (Larsen and Shah, 1992; Burniaux et al., 1992; Steenblik and Coroyannakis, 1995; Anderson and McKibben, 1997; IEA, 1999; Saunders and Schneider, 2000; and Burniaux et al., 2009)[65] and single-country CGE models (Clarke and Edwards 1997; Jensen and Tarr, 2002; Clement *et al.*, 2007; Nwafor *et al.*, 2006; Yusuf and Ramayandi, 2008; Dartanto, 2011; Breisinger *et al.*, 2011). While comparability of results in relation to the size of the subsidies is very limited in multi-region CGE models - given the different reference years of the studies, the different countries incorporated in each study, and the different approaches to aggregating the subsidies, country-specific studies offer more transparency in the modelling of fuel subsidy reform. Also, almost all multi-region/country CGE studies focus on economic and environmental impacts while single-country studies makes extra effort to capture social/distributional effects. To keep the study in context, only the review of economic and household effects of subsidy reform is presented.

[64] Economic sectors that use energy as a significant input are likely to experience higher productions costs (and therefore, higher prices) due to higher energy prices.
[65] With the exception of Anderson and McKibben, 1997 that examined the effects of coal subsidy removal, all other studies considered a variety of fossil-fuel.

(i) Economic effects

Burniaux *et al.*, (1992), Larsen and Shah (1992), Clarke and Edwards (1997), IEA (1999), Saunders and Schneider (2000), Jensen and Tarr (2002), Hartono and Resosudarmo (2006), Burniaux *et al.*, (2009), and Breisinger *et al.*, (2011) found that economic effects (usually measured in terms of changes in GDP)[66] from subsidy reform are positive at an aggregate level due to enhanced price incentives that leads to better resource allocation. Clement *et al.*, (2007), however, find in his study for Indonesia that fossil-fuel producer subsidy reform (within a Keynesian model) would reduce real output in the short-term, but when considered in a non-Keynesian model real output experiences no decline.[67]

(ii) Households effects and the re-targeting of budgetary surplus

Studies on household effects of fuel subsidy removal have been considered mostly at country-specific level. With the exception of Jensen and Tarr (2002) who found that fossil-fuel subsidy reform in Iran increased welfare by 33%, most studies find evidence that fuel subsidy reforms have negative household effects. For instance, with an 80% increase in prices resulting from energy subsidy reform in Poland, Freund and Wallich (2000) found that households experience welfare decline of about 8.2% (for the richest quintile) and 5.9% (for the poorest quintile. Although this finding was based on the assumption of zero elasticity of demand, impacts were found to range from 4.6% to 7.6% of households' total budget when elasticity of demand was varied.

For Indonesia, Clements *et al.*, (2007) found, using a Keynesian model, that fuel producer subsidy reform reduces real consumption of households between 2.1% and 2.9%. This decline in real consumption was much larger than the 0.9% obtained in their estimation of a non-Keynesian model. They noted that high-income groups in urban and rural areas were affected because of their relatively high consumption of petroleum products. Coady *et al.*, (2006) also find that real incomes of the poorest household groups declined between 1.8% in Mali up to 9.1% in Ghana, but that the size effects depended largely on the size of the subsidy removed. They noted that (with the exception of Bolivia and Mali) the direct effects were distributionally regressive. That is, the share borne by low-income groups is greater than their share of total income. However, they observed that the indirect effects tended to be equally

[66] Some studies report net increases in GDP or real income by the end of the model run, while some others report (per annum increases in GDP or income over the course of the simulation period.
[67] In the Keynesian model, labour is assumed to be mobile but capital immobile while in the non-Keynesian model capital was assumed to be mobile.

distributed across all income quintile. Across all the countries studied they found that a 50% average increase in fuel prices resulted, on average, in a 4.6% decrease in real incomes. Other studies which found that fuel subsidy cut reduces households' real income, and thus welfare include Oktaviani *et al.*, (2005), Yusuf and Ramayandi (2008).

As regards re-targeting of budgetary surplus, studies have shown that the targeting option adopted by government have a strong implication on the overall effects of the reform. For instance, Jensen and Tarr (2002) found that with more targeted transfer of saved money from the reform the poorest households' welfare increased in rural areas by 200% and in urban areas by 100%. Coady *et al.*, (2006) also found in their five-country study that a well-targeted direct transfer of budgetary surplus would be more beneficial to all households than existing subsidies since 40% of benefits would accrue to the poorest 40% of households. Hartono and Resosudarmo (2006) argued that without income transfer to the poor or mis-management of the compensation programme, most poor households' incomes will be worse-off in comparison with the period before the reform; however, income transfer as compensation to reducing fuel subsidy increases household incomes.

Recent studies also support prior evidence that direct transfers strongly smoothens the negative impacts on households but that the impact of transfers strongly depended on the efficiency of service delivery (Breisinger *et al.*, 2011). Direct transfers combined with investment in infrastructure (Breisinger et al., 2011) as well as investments on human capital (Dantarto, 2011) have been found to produce stronger poverty-reducing effects. However, reallocation budget might not effectively compensate the adverse impacts of a 100% removal of fuel subsidies if the economic agents try to seek gains through mark-up pricing surpassing the increase in production costs (Dantarto, 2011). There has also been empirical support that accelerated reform is more beneficial than gradual reform because more resources become available for investment, which then translates into economy-wide growth effects (see Breisinger *et al.*, 2011). Some other options on the re-targeting of surplus include saving the surplus to finance government deficit (Breisinger et al., 2011) or recycling the revenue through reducing the rate of indirect tax (Yusuf and Ramayandi, 2008).

3.5 Concluding remarks

From the review it is clear that analyse of the impact of international commodity price shocks on households will continue to depend on a number of factors including the conceptual definition and measurement of the shocks, as well as the methodological approach employed. Also, while cross-country analysis provides important information on the household impact of shocks, however, given the structural differences among countries, country-specific studies tend to provide more detailed or specific effects of the shock-effects. As regards studies conducted using the CGE framework, key observations are that (i) the size, measurement, and nature of fossil-fuel subsidy removed have bearing on the results; (ii) the underlying assumptions of the models, and lack of transparency in many of the modelling studies limits result-comparison of different studies; and (iii) specifically for energy reform policy shock, re-targeting option of budgetary surplus have implication on the overall effect of the policy shock.

CHAPTER 4

CONCEPTUAL FRAMEWORK AND THEORETICAL STRUCTURE OF THE MODEL

4.1 Introduction

The review of theoretical literature reveals a multiplicity of channels via which international commodity price shocks impacts on households. To account for the various channels simultaneously most empirical studies have been founded on the general equilibrium theory. This chapter seeks to do two things: provide the theoretical framework that guides the thought-process of the analytical structure of the study; and, present a conceptual framework which describes the operationalization of the theoretical framework. This chapter is organised into four sections. Following this introduction, Section 4.2 presents the theoretical framework for the study. Section 4.3 discusses the conceptual guide of the study, while the last section concludes with a summary.

4.2 Theoretical framework: The competitive general equilibrium theory

The basic theoretical framework of this study is based on the competitive general equilibrium thoery founded strongly on Walrasian theory of market behaviour. Its initial structure was developed in the second half of the 19th century by neoclassical economists including Jevon (1871), Menger (1871), and Walras (1874-1877). The latter, however, is widely recognized as a major contributor to the design of the framework. In the 20th century, the framework was formalised by the notable works of Arrow and Debreu (1954), and McKenzie (1959, 1981).

The competitive general equilibrium theory seeks to explain the behaviour of supply, demand and prices in a whole economy with several interacting markets as well as the interactions among economic agents. Thus, it is quite suitable for explaining the perturbation caused by external shocks (such as the price shocks considered in this study) in an economy, and households effects in particular.

The theoretical framework guiding this study draws from the works of Wing (2004), Hosoe (2004), and Decaluwe *et al.*, (2000). The main points emphasized in the theory and the specific adjustments made to suit the study at hand are discussed in the sub-sections below.

4.2.1 Producers and households

The framework begins by describing a finite number of producers (*N*), each producing its own type of commodity (which may be production outputs or intermediate consumption inputs), and an unspecified number of households that jointly own an endowment of *F* different types of primary factors. Then, letting the indices j = (1,2,...,N) denote the set of industry sectors - each producing its own type of commodity, i = (1,2,...,N) denote the set of commodities, f = (1,2,...,F) the set of primary factors, and d = (1,2,...,D) the set of final demands, the behaviour of the agents within the system is described as below.

(i) Producers

Each producer j is faced with a set of production possibilities in which outputs have a positive sign and inputs a negative sign. The set of production programme has the following properties: production without input is impossible, the scale outputs are non-increasing, and the production process is irreversible. The production procedure is disaggregated into two stages. At the bottom stage, it is assumed that value added (or composite primary factor) is produced from labour and capital with the Constant Elasticity of Substitution (CES) type production technology. At the top stage, it is assumed that gross outputs are made from the value added and intermediate inputs with Leontief type production technology. In the Leontief type production technology inputs are used in fixed proportions to the level of output, thus it is characterised by zero substitutability. However, the CES type production technology allows for flexibility in input substitutability (see Pauw *et al.*, 2004).

Each producer maximizes profit π by choosing the levels N of intermediate inputs X_j and composite primary factors (value-added) Y_j to produce output Z_j, subject to the constraint of its production technology. Thus, the j^{th} producer's problem is to:

$$\max_{Z_j, X_{ij}, Y_{fj}} \pi_j = p_j Z_j - \sum_{i=1}^{N} p_i X_{ij} - \sum_{f=1}^{F} w_f Y_{fj}$$

subject to $$Z_j = \min\left[\frac{X_{ij}}{a_{oij}}, \frac{Y_{fj}}{a_{1fj}}\right] \tag{7}$$

Where P_j, P_i, and w_f are the prices of industrial output, intermediate inputs and value-added respectively; and a_{oij} and a_{1fj} are input-output coefficients for intermediate inputs and composite factor inputs.

Each producer is assumed to have a Leontief production technology, so that its production function, $\min\left[\frac{X_{ij}}{a_{oij}}, \frac{Y_{fj}}{a_{1fj}}\right]$, is a recipe for combining inputs of intermediate goods and composite primary factors.

By rearranging the constraint in (7), the input-output coefficients (parameters) of the Leontief production function are:

$$a_{0ij} = \frac{X_{ij}}{Z_j}, \quad \text{and} \quad a_{1fj} = \frac{Y_{fj}}{Z_j} \tag{8}$$

Solving the problem in (7) yields producer *j*'s demands for intermediate inputs of commodities:

$$X_{ij} = a_{0ij} Z_j \tag{9}$$

and its demand for composite factor inputs:

$$Y_{fj} = a_{1fj} Z_j \tag{10}$$

Rearranging equations (9) and (10) yields

$$a_{0ij} = \frac{p_i X_{ij}}{p_j Z_j} \quad \text{and} \quad a_{1fj} = \frac{w_f Y_{fj}}{p_j Z_j},$$

respectively, showing that the coefficients of the Leontief production function represent the shares of their respective inputs to production in the value of output.

However, since equation (7) is not differentiable[68], it is replaced with a zero-profit condition expressed as:

[68] This is because the Leontief type production function in the constraint is not differentiable with respect to its inputs. To take a formal derivation of the function, a CES function, which is a generalized function of Leontief function, for a production function is employed. As the elasticity of substitution in a CES function tends to zero, it does to a Leontief function.

$$\pi_j = p_j Z_j - \sum_{i=1}^{N} a_{0ij} p_i Z_j - \sum_{f=1}^{F} a_{1fj} w_f Z_j = 0, \quad \forall j \tag{11}$$

This zero-profit condition is justified by the assumption that all the firms are competitive and cannot earn excess profits. In the event that some firms can earn excess profit, there will be entry of firms to reduce excess profits (per firm). Entry will continue until the excess profits disappear. The condition expressed in (11) can further be simplified into the unit cost function by dividing the zero-profit condition with gross outputs:

$$p_j = \sum_{i=1}^{N} a_{0ij} p_i + \sum_{f=1}^{F} a_{1fj} w_f \qquad \forall\ j \tag{12}$$

(ii) Households

The representative households are assumed to maximize their utility U by choosing their level of consumption c of the N commodities in the economy, subject to their income constraints y and prevailing commodity prices p. Their income consists of earnings from its endowment of primary factors, which are inelastically supplied to industry for production, as well as income in the form of transfers. Thus, the agent's problem is to:

$$\max_{c_i} U(c_1, \ldots, c_N)$$

subject to $$y = \sum_{i=1}^{N} p_i c_i \tag{13}$$

The representative households are assumed to have Stone-Geary utility function (from which derives the Linear Expenditure System)[69] expressed as:

[69] Several alternative formulations such as the almost ideal demand systems (AIDS) by Deaton and Muellbauer, the Rotterdam model by Theil, and Barten, and the linear expenditure system (LES) by Stone have been used to represent household demand system in the literature. However, as pointed out by Vargas (2004), a theoretically consistent demand system permits imposition of the general restrictions of classical demand theory. These restrictions include: (i) adding-up: value of total demands equals total expenditure; (ii) homogeneity: demands are homogeneous of degree zero in total expenditure and prices; (iii) symmetry: cross-price derivatives of the Hicksian demands are symmetric; and (iv) negativity: direct substitution effects are negative for the Hicksian demands. The linear expenditure system is the most commonly used due, in part, to convention and because it allows representation of subsistence consumption, in addition to satisfying the above restrictions.

$$U(c)=\sum_{i=1}^{N}\beta_i \ln\left(c_i-\gamma_i\right),$$

$$\sum_{i=1}^{N}\beta_i=1 \tag{14}$$

where c_i is the level of commodity i, β_i is the marginal budget share of the commodity, and γ_i if positive, is subsistence minima as perceived by the consumer.[70]

It is further assumed that only a fixed amount of household disposable income can be allocated to consumption (given that household pay direct taxes to government and are allowed to save a portion of their income). Therefore, the household constraints in (13) can be redefined as:

$$dy=\sum_{i=1}^{N}p_i c_i \tag{15}$$

where dy is households consumption budget, derived after deducting taxes and savings.

Solving the first order conditions of the Lagrangean of equations (14) and (15) produces:

$$\frac{\beta_i}{c_i-\gamma_i}=\lambda p_i \tag{16}$$

$$dy-\sum_{i=1}^{N}p_i c_i=0 \tag{17}$$

Rearranging the terms in (16), summing across i, and solving for the Lagrangean multiplier, yields:

$$\lambda=\frac{1}{dy-\sum_{i=1}^{N}p_i c_i} \tag{18}$$

[70] Contrary to Cobb-Douglas utility functions, often used in the literature, this utility function imposes neither zero cross-price elasticities between all pairs of goods, nor unit income-elasticities for all goods. Thus, it offers a degree of flexibility with respect to substitution possibilities in response to relative price changes.

Recall that $\sum_{i=1}^{N}\beta_i = 1$. Substituting (18) into (16) produces an expression for the expenditure on commodity *i* by household:

$$p_i c_i = p_i \gamma_i + \beta_i \left(dy - \sum_{i=1}^{N} p_{ij} \gamma_{ij} \right) \tag{19}$$

As expected, the first derivative of equation (19) with respect to household consumption budget *dy* is the marginal budget share, β_i. Dividing equation (19) by p_i gives the linear expenditure system, equation (20), which represents the representative agent's demand function for the consumption of the i^{th} commodity:

$$c_i = \gamma_i + \frac{\beta_i}{p_i} \left(dy - \sum_{i=1}^{N} p_{ij} \gamma_{ij} \right) \tag{20}$$

To be estimable, equation (20) is often implemented using a simplified version of the Stone-Geary LES. Rearranging equation (20) gives:

$$\gamma_i - \frac{\beta_i}{p_i} \sum_{i=1}^{N} p_{ij} \gamma_{ij} = \frac{dy}{p_i} \left(\frac{p_i c_i}{dy} - \beta_i \right) \tag{21}$$

4.2.2 Government, capital stock and investment

(i) Government

Government is assumed to impose indirect taxes on production (TXp_j) and commodities (TXc_i), and direct taxes on household income (TXh) expressed by:

$$TXp_j = \tau_j Z_j, \qquad \forall \ j \tag{22a}$$

$$TXc_i = \tau_i Z_j \ , \qquad \forall \ i \tag{22b}$$

$$TXh = \upsilon y \tag{22c}$$

where τ and υ represents indirect and direct tax rate respectively.

If government spends its revenue less savings (S^g) in the consumption of commodities

(X_i^g), then government behaviour can be expressed as:

$$X_i^g = \frac{\mu_i}{p_i}\left(\sum TX - S^g\right) \qquad (23)$$

where $\sum TX$ is the sum of all tax revenue, and μ_i is the share of expenditure for the i^{th} commodity $(0 \le \mu_i \le 1, \sum_i \mu_i = 1)$.

Assuming government receives income transfer from other agent (tr_o^g) and also transfer income to other agents (tr_g^o); if government also commits a portion of its budget on subsidizing the consumption of a particular commodity (B_i), then the government's budget constraint can be defined as:

$$Y^g \equiv \sum TX + tr_o^g = p_i\left(\frac{X_i^g}{\mu_i}\right) + tr_g^o + B_i + S^g \qquad (24)$$

This is just one specification, it can be assumed also that besides its consumption of commodity, government allocates a fixed portion of its budget on capital expenditure. Thus, equation (24) may include an extra variable in the right hand side (RHS). In addition, there can be alternative treatment of the subsidy (B_i) in the system. It may be treated as an arbitrary lump-sum payment to producers or consumers or may take the form of price controls that set prices below full cost.[71] The latter treatment suggests that B_i depends on the market price and consumption of the specific commodity being subsidized.

(ii) Capital stock and investment

To maintain consistency within the accounting framework, either of two approaches can applied in the treatment of capital good. The first considers heterogeneous capital, while the second considers one capital aggregate.[72] The latter approach requires aggregating sectoral investment by fixed shares to a composite capital. Implying that, outputs of the industries combine, according to fixed coefficients, to produce a

[71] This first possibility is simple and transparent but can involve considerable accounting and transaction cost in reality. It also imposes a heavy direct financial burden on national treasury. The alternative, is often preferred if the specific-commodity-producing firm is state-owned.

[72] Farmer and Wender (2001), have argued that simulation results of dynamic CGE models are quite sensitive to the respective specification of capital and investment aggregation. While recommending employing a framework with optimal investment shares and heterogeneous capital (pointing out three great complexities in implementing the framework), they highlighted some circumstances under which the one capital aggregate and fixed investment shares appear more justifiable. One include, analysis in the case where the composition of capital inputs is identical across sectors.

representative capital aggregate. It should be noted that investment shares are not exogenously fixed; they react to changes in relative prices as well as policy shocks.

Thus, similar to the assumption made about government consumption, investment demand function with constant share parameters can be expressed as:

$$X_i^v = \frac{\lambda_i}{p_j}\left(S + S^g + \varepsilon S^f\right) \qquad \forall \ i \qquad (25)$$

where: S is private saving; S^f is foreign savings (or current account deficit in balance of payments) in foreign currency; X_i^v is the investment demand for the i^{th} commodity; ε is the exchange rate (local currency per foreign currency); and, λ_i is the share of expenditure for the i^{th} commodity.

This investment demand determined by equation (25) is a major demand component. It is realized by the combination of domestic and foreign savings. In a dynamic system, it is made to contribute to capital good. The value of capital good K_t, holds that:

$$K_{t+1} = p_{j,t} X_{i,t}^v \qquad (26)$$

and total savings in period t equals K_{t+1}. The quantity of capital good, in terms of commodity i, is denoted as $k_{t+1} \equiv K_{t+1} / p_{j,t}$. Recall that investment demand is determined by exogenously fixed (nominal) shares of total savings, ς, so

$$X_{i,t}^v = \varsigma k_{t+1} \qquad (27)$$

4.2.3 International trade

(i) The small-country assumption and the balance of payments constraint

In this sub-section, the framework is extended to an open economy model. For simplicity, the small-country assumption (that this country is too small to affect international market prices) is employed. Thus, import and export prices (p_i^{Wm} and p_i^{We}, respectively) the country faces are given in foreign currency terms. Given the exchange rate, ε, the relationships between import and export prices in local and foreign currency terms are shown in the following equations:

$$p_i^e = \varepsilon p_i^{We}, \qquad (28a)$$

$$p_i^m = \varepsilon p_i^{Wm}, \tag{28b}$$

Introducing taxes on imports and exports of commodities modifies the relationship between import and export prices to equations (29a and b), while the balance of payments condition of this country, described in foreign currency, is given by equation (30).

$$p_i^e = p_i^{We}(1+t_i^e)\varepsilon \tag{29a}$$

$$p_i^m = p_i^{Wm}(1+t_i^m)\varepsilon \tag{29b}$$

$$\sum_i p_i^{We}(1+t_i^e)E_i + S^f = \sum_i \varepsilon p_i^{Wm}(1+t_i^m)M_i, \tag{30}$$

where E_i and M_i are the amounts of exports and imports of the i^{th} commodity, respectively.

(ii) The Armington assumption

With the extension of the framework to an open economy model, some consideration about the substitutability among imported, exported, and domestically supplied good are needed. If exported goods are perfectly substitutable with imported ones, then the problem caused by two-way trade in actual trade statistics is inescapable.[73] To resolve this problem, exported goods are regarded imperfect substitutes for imported ones even though they are statistically classified into the same category.

An aggregation stage is assumed, in order to treat imports and domestic goods as different goods, and a disaggregation stage for exports and domestic goods. Thus, imports and domestically supplied goods are aggregated to be (Armington's) composite goods – used for intermediate inputs and domestic final demand. It is assumed that imports are imperfectly substitutable with domestic goods; that is, the goods are heterogeneous with respect to their origin.[74] The imperfect substitutability between the two is expressed with a CES type production function.

The profit maximization problem of the i^{th} composite good firms is:

$$\max_{Q_i, M_i, D_i} \pi_i^q = p_i^q Q_i - \left(p_i^m M_i + p_i D_i\right),$$

[73] See Hosoe (2004) for more discussion on this.
[74] This is called the Armington's (1969) assumption.

subject to $$Q_i = \varphi_i \left(\delta m_i M_i^{\eta_i} + \delta d_i D_i^{\eta_i} \right)^{\frac{1}{\eta_i}}, \quad \delta m_i + \delta d_i = 1, \; \delta m_i, \delta d_i \geq 0 \tag{31}$$

where: π_i^q is the profit of the i^{th} composite good firm; p_i^q is price of the i^{th} composite good; Q_i is output of the i^{th} composite good; D_i is the input of the i^{th} domestically produced good; φ_i is the productivity parameter of the i^{th} composite good production function; $\delta m_i, \delta d_i$ are the share parameters of the i^{th} composite good production function; η_i is the parameter related to elasticity of substitution, $\left(\eta_i = (\sigma_i - 1)/\sigma_i, \eta_i \leq 1\right)$; and σ_i is the elasticity of substitution[75].

From the first-order conditions of the optimization problem, the following demand functions for imports and domestic goods can be obtained.

$$M_i = \left(\frac{\varphi_i^{\eta_i} \delta m_i p_i^q}{p_i^m} \right)^{\frac{1}{1-\eta_i}} Q_i, \tag{32}$$

$$D_i = \left(\frac{\varphi_i^{\eta_i} \delta d_i p_i^q}{p_i^d} \right)^{\frac{1}{1-\eta_i}} Q_i, \tag{33}$$

At another level, producers are considered to transform gross outputs into exports and domestic goods. These exportable goods are also assumed to be imperfectly transformable to domestic goods. This is represented by means of a constant elasticity of transformation (CET) production technology. Thus, the optimization problem of the i^{th} transformation firm is shown as:

$$\max_{Z_i, E_i, D_i} \pi_i^Z = \left(p_i^e E_i + p_i^d D_i \right) - \left(\tau_i + p_j \right) Z_i$$

subject to $$Z_i = \theta_i \left(\xi e_i E_i^{\phi_i} + \xi d_i D_i^{\phi_i} \right)^{\frac{1}{\phi_i}} \qquad \xi e_i + \xi d_i = 1, \quad \xi e_i, \xi d_i \geq 0 \tag{34}$$

[75] The elasticity of substitution, which is assumed constant in the CES function, represents the marginal decreases in relative amount of inputs under marginal increases in relative input prices.

Here, it is given by $\sigma_i \equiv -\frac{d\left(M_i / D_i\right)}{M_i / D_i} / \frac{d\left(p_i^m / p_i^d\right)}{p_i^m / p_i^d}$

where: π_i^Z is the profit of the i^{th} transformation firm; θ_i is the productivity parameter of the i^{th} firm's transformation function; $\xi e_i, \xi d_i$ are the share parameters of the i^{th} firm's transformation function; ϕ_i is the parameter related to elasticity of transformation, $\left(\phi_i = (\psi_i + 1)/\psi_i,\ \ \phi_i \geq 1\right)$; and, ψ_i is the elasticity of transformation of the i^{th} firm's transformation function[76].

From the first-order conditions of the optimization problem, the transformation function and supply functions of exports and domestic goods can be obtained as:

$$E_i = \left(\frac{\theta_i^{\phi_i} \xi e_i \left(\tau_i + p_j\right)}{p_i^e} \right)^{\frac{1}{1-\phi_i}} Z_i, \qquad (35)$$

$$D_i = \left(\frac{\theta_i^{\phi_i} \xi d_i \left(\tau_i + p_j\right)}{p_i^d} \right)^{\frac{1}{1-\phi_i}} Z_i, \qquad (36)$$

4.2.4 General equilibrium

To ensure general equilibrium in the system, there is need for market-clearing conditions in all the markets (for goods and factors). Market clearance implies that the quantity of each commodity produced must equal the sum of the quantities of that commodity demanded as an intermediate input, by representative agent (households and government) for consumption, or as investment goods. Thus, we have

$$Q_i = X_i^p + X_i^g + X_i^v + \sum_j X_{ij}, \qquad \forall i \qquad (37)$$

In addition, the quantities of primary factor f used by all producers must equal the representative agent's endowment of that factor, Y_f. This is given by

$$Y_f = \sum_{j=1}^{N} a_{1fj} \qquad (38)$$

The zero profit condition implies that the value of output generated by producer j must equal the sum of the values of the inputs of the i^{th} intermediate goods and f primary

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[76] Similarly, like the CES, the CET is given by $\psi_i \equiv \frac{d\left(E_i / D_i\right)}{E_i / D_i} / \frac{d\left(p_i^e / p_i^d\right)}{p_i^e / p_i^d}$

factors employed in production. This condition is derived by rearranging the RHS of equation (11):

$$p_j Z_j = \sum_{i=1}^{N} a_{0ij} p_i X_{ij} - \sum_{f=1}^{F} a_{1fj} w_f Y_{fj} \qquad (39)$$

Income balance implies that the income of the households must equal the value of producers' payments for the use of the primary factors. Thus,

$$y = \sum_{f=1}^{F} w_f Y_f \qquad (40)$$

These equilibrium conditions, including equation (26) form the binding elements in the system of equations which are the building blocks of the model.

4.3 Conceptual framework

The fundamental conceptual starting point for any general equilibrium analysis on household effects of international commodity price shock is an understanding of the linkages in the economy under study. Equally important is the interaction of the economy with the external world. One goal of this section is to explain these linkages. The second is to describe how, via these linkages, international commodity price shocks are *possibly* transmitted to households. By achieving these two goals, this section describes the operationalization of the theoretical framework discussed in the previous section. It is worth pointing out that this section draws largely from the works of Wing (2004), Piermartini and Teh (2005), and Benson *et al*., (2008).

4.3.1 The open economy circular flow

The economy under study is a small open economy. This presupposes two things: one, that the country relates with other countries (referred to as the rest of the world – ROW); and two, it cannot influence international price. The main actors in this economy are: (i) households, who own the factors of production (such as land, labour, and capital) and are the final consumers of produced commodities; (ii) firms, who rent the factors of production from the households for the purpose of producing goods and services that are consumed by households, government and other firms; (iii) government, that collect taxes and disburse these revenues to firms and households as subsidies and lump-sum transfers, subject to rules of budgetary balance; and (iv) the rest of the world (ROW), that buys goods from the domestic market, and sells to same.

In describing the linkages in this economy, one can start with the supply of factor inputs to the firms, and then continue to the supply of goods and services from the firms to the households, who in turn control the supply of factor services. Given that the economy is open, supply of goods and services include those produced domestically and imported. Alternatively, one may begin with payments made to households for the services of labour and capital they provide to firms, which are then used as income to pay producing sectors for the goods and services that the households consume.

Equilibrium in these economic flows results in the conservation of both product and value. Conservation of product implies that firms' outputs are fully consumed by households, and that households' endowment of primary factors is in turn fully employed by firms. Thus, for a given commodity the quantity produced must equal the sum of the quantities that are demanded by the other firms, government and households in the economy. Also, for a given factor the quantities demanded by firms must completely exhaust the aggregate supply endowed to the households.

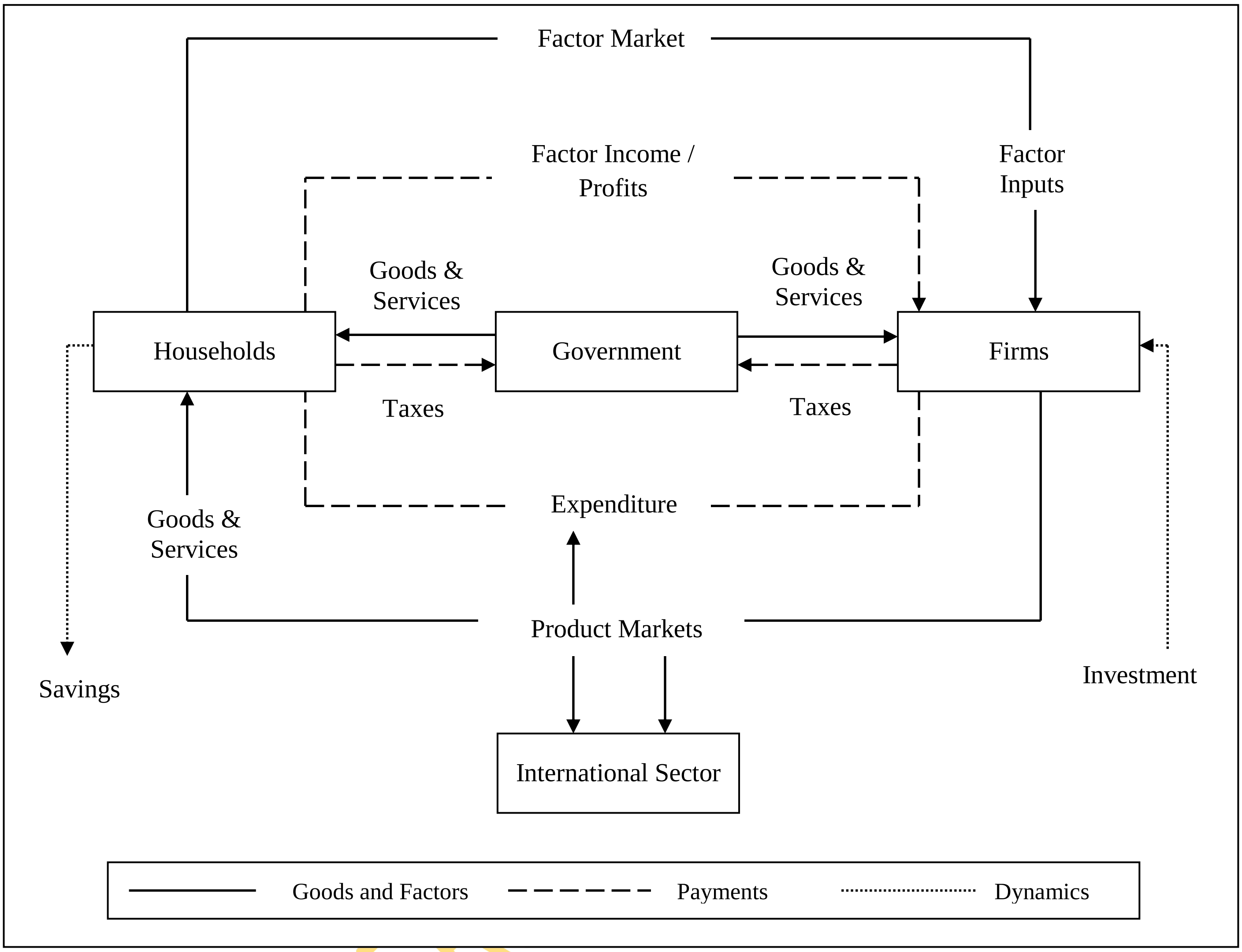
Conservation of value, on the other hand, implies that the sum total of revenue from the production of goods must be allocated either to households as receipts for primary factors rentals, to other industries as payments for intermediate inputs, or to the government as taxes. The value of a unit of each commodity in the economy must then equal the sum of the values of all the inputs used to produce it; that is, the cost of the inputs of intermediate materials as well as the payments to the primary factors employed in its production.

Payments made to households associated with the value of factor rentals to producers, accrue to households as income which the households exhaust on goods purchases. If households save part of their income, the forgone consumption must be equal to investment, which allows the economy to increase its productive potential over time. In a dynamic sense where the time path of equilibria that the economy tracks matter, investment determines how fast the economy grows.[77]

[77] The economy's investments at any given time are a flow; capital stock is the accumulation of all past investments made by the economy. Hence, changes to the economy over time occur through the effect that changes in flow have on stock variable.

Figure 4.1 describes the flow of goods and services or expenditures and receipts in an open economy. Each economic transaction that involves an exchange of goods or services must be matched by a corresponding flow of expenditures and receipt of payment. For example, the transaction involving households purchasing goods produced by firms is depicted as both a flow of goods (plain line) and a flow of payments (dashed line). The flow of goods moves from firms to households, while the flow of payments moves in the opposite direction from households to firms.

The link between the domestic economy and the international sector is captured with the four sets of arrows that lead to and out of the international sector. The international sector is a source of additional goods and services (imports) to the domestic economy. This is matched by a payment flow from domestic agents to foreigners. But some of the goods and services produced in the domestic economy also go to the international sector as exports. This outward flow of goods and services is matched by an inward flow of payments to domestic producers.



Source: World Trade Organisation (WTO), 2012.

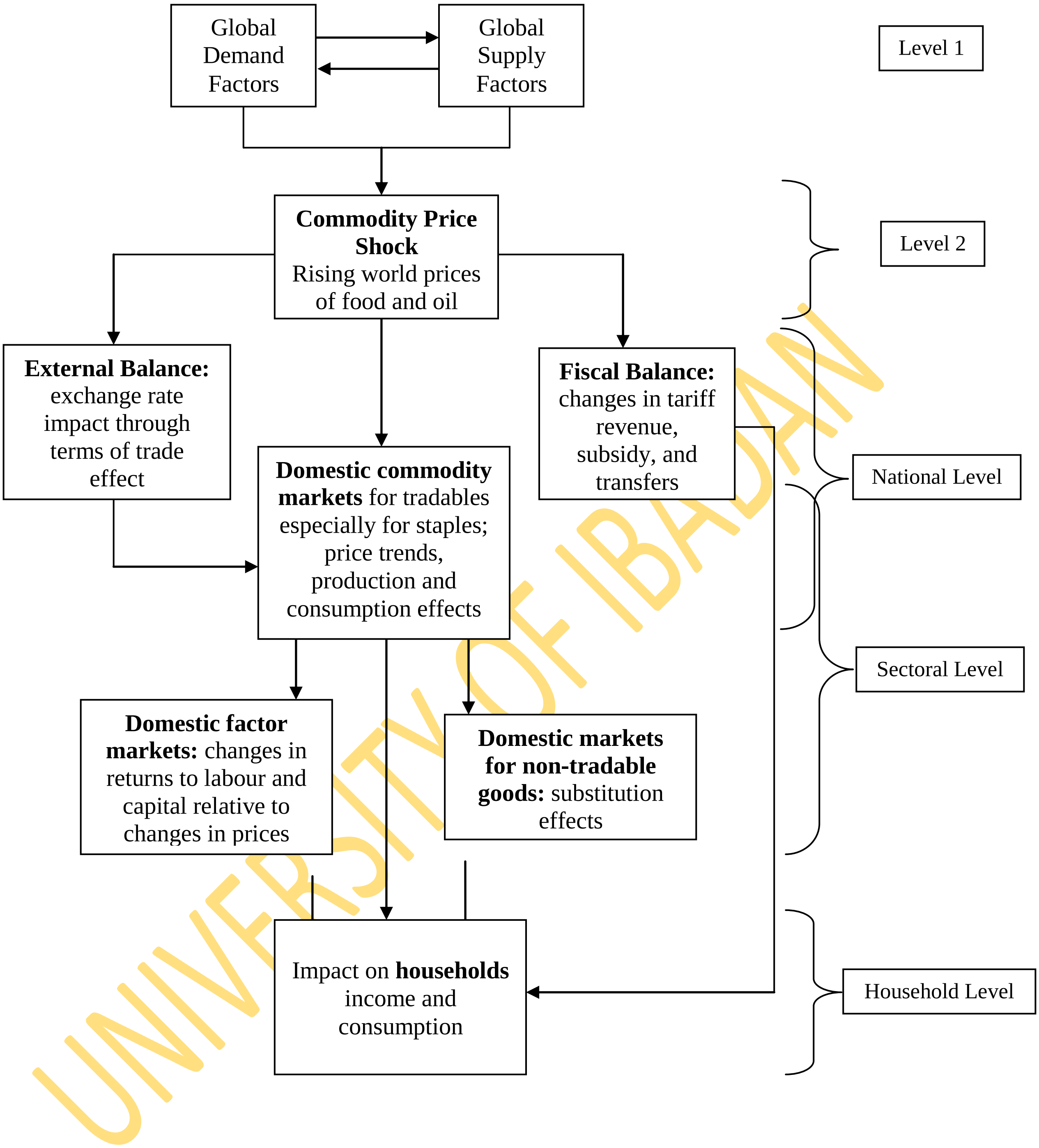
Figure 4.1. Circular flow in an open economy

4.3.2 The conceptual linkages

Volatility of international commodity prices has negative repercussions on the aggregate economy as abundantly shown by the literature. Figure 4.2 is a conceptual diagram of how changes in global commodity prices (food and refined oil, in particular) affect the national economy, the operations of government, and product and factor markets. These adjustments result in some immediate short-term effects on the incomes of households. Finally, changes in the economic condition of the household will lead to changes in the well-being of the households.

The process starts at the top with the interaction of factors governing global demand for and supply of food and oil. The factors include increased costs of food production, processing, and marketing linked to sharply higher oil prices; the use of food crops for biofuel production; poor harvests in certain major agricultural regions; consistent underinvestment in agriculture over past decades resulting in agricultural production that lags behind population growth or broader economic growth; political events in the Middle East and other major oil producing nations; and global economic recession. These factors reinforce each other, and significantly contribute to volatility in the international prices of these primary commodities (food and oil), at the second level.

At the national level, four key elements contribute to the aggregate national impact. They are: changes in fiscal balance, external balance, local commodity markets, and local factor markets. How these key elements contribute to the aggregate national impact is sharpened by structural and institutional factors such as regulations/interventions in the domestic market, vulnerability (determined by the country's degree of trade and dependence on those commodities), and trade policies. At the sub-national level, elements that contribute to industry level or sectoral level impact include activities in the commodity markets (tradable and non-tradables), and factor market which depend largely on the level of development, regulation, and interlinkages in these markets.



Source: Adapted from Benson *et al.*, (2008).

Figure 4.2. Conceptual framework linking international commodity price shocks to households

Volatility in food and oil prices can affect government revenue and expenditure in several ways. For instance, changes in the volume and value of trade due to shocks to food and oil price will influence tariff revenue – an important source of revenue for government. Also, changes in the prices of these commodities will affect government spending on subsidies. In Nigeria, where government provide some subsidy to agricultural production and domestic fuel consumption, changes in the prices of these traded commodities can, in fact, lead to skyrocketing of subsidy costs. This is particularly true if the after-subsidy price, rather than the size of the subsidy, is fixed. This inevitably may debilitate government's ability to fund programmes that are geared towards increasing social welfare. Any adverse fiscal impact of the shock can be transmitted to households in the form of higher taxes or reduced provision of goods and services.

Shocks to the price of food and oil can affect both imports and exports, and the market for foreign currency through changes in the terms of trade. Being a net importer of these commodities, higher international prices result in a decline in the terms of trade in Nigeria. In a flexible exchange rate regime, the increased demand for foreign currency results in depreciation of the country's currency. Alternatively, assuming exchange rate is fixed, the effect will be a reduction in foreign currency. Whatever the case, the impact is eventually transmitted to households in the form of higher relative prices for households purchasing tradable goods but higher returns for households engaged in the tradable good sector (export and import-substitute goods).

Depending on a number of factors, including: the type of commodity, the degree of openness, and the distance between the country and the global market centres, higher international prices may generally translate to higher domestic market price. For commodities that are widely traded such as oil, wheat, rice, and maize, their domestic price often reflects international prices. In the Nigerian case, however, refined oil price does not reflect international price because of government regulation of energy prices (particularly, petroleum motor spirit). As for commodities that are not widely traded, the impact of international prices on local prices is likely to be reticent. The overall effect in the commodity market, at national level, is reflected in the country's GDP which measures the value of goods and services produced in a country in any given year. At the sectoral level, higher domestic prices of food (major staples) can lead to rise in domestic prices of other food types as consumers seeking lower-priced substitutes shift their food consumption to the available substitutes.

Ideally, in the case of oil, since oil is a factor of production in most sectors and industries, a rise in oil prices increases the enterprises' production costs, thereby, stimulating contraction in output (Jimenez-Rodriguez and Sanchez, 2004). Given a firm's resource constraints, the increase in the prices of oil as an input of production reduces the quantity it can produce. Hunt *et al*., (2001) added that an increase in input costs can drive down non-oil potential output supplied in the short run.

According to Verleger (1994), oil price volatility shrinks investment activities in production of oil. Hamilton (1996) also pointed out that oil prices variability and oil supply disruptions could cause postponement of investment decisions in the economy. There is also a possibility of a period of adjustment within an economy when prices of oil increase. As oil becomes relatively expensive vis-à-vis other intermediate goods, energy-intensive industries contract their production whereas less energy-dependent sectors and more efficient users expand.

With higher prices of commodities, particularly food, there will be upward pressure on wage rates as workers will seek to earn higher wages in order to re-establish their previous purchasing power.

The conceptual diagram shows that households are directly affected by the price of food and other commodities the households consume, as well as the prevailing wage rate. Also, they are affected by the fiscal balance of government through changes in taxes and in transfers. From the perspective of external balance, households are affected indirectly by changes in the exchange rates which affect the relative prices of tradable and non-tradable goods households face in the market. It is possible that the impacts would vary among different household categories depending on their ownership of factors.

4.4 Concluding remarks

Motivated by the need to account for the multiplicity of channels via which macro shocks can be transmitted to household, this section described the basic theoretical underpinnings that gives frame to the methodology adopted in the study. The framework explains the behaviour of supply, demand and prices in a whole economy with several interacting markets. The interactions of these markets as well as the agents therein were further described conceptually using an open circular flow. How the shocks feed through the system to household was also conceptually described. Principally, households may be affected due to changes in fiscal balance, external balance or interactions in the factor and commodity markets.

CHAPTER 5

RESEARCH METHODOLOGY: COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR THE NIGERIAN ECONOMY

5.1 Introduction

The aim of this chapter is to present the main features of the CGE model employed in this study to analyse households' effects of international commodity price shocks in Nigeria. A recursive-dynamic CGE model developed by Decaluwe *et al.*, (2012) - a modification of the 2010 version of the PEP-1t[78], was adapted for the study. The starting point in describing a CGE model is the Social Accounting Matrix (SAM) – the database of the model. Thus, in Section 5.2 the 2006 Nigeria SAM which reflects the structure of the Nigerian economy is discussed. The model's blocks and equations are presented in Section 5.3. Also presented in the section are the macro closures of the model. The simulation scenarios are presented in Section 5.4 while the procedure of model solution is described in Section 5.5. The final Section, 5.6, presents the concluding remarks.

5.2 The social accounting matrix (SAM) of Nigeria

A SAM is a square matrix comprising rows and columns that represents the different activities, commodities, agents, and institutions of an economy. Each cell in the matrix represents the flow of economic activities in monetary terms from a column account to a row account (Nwafor *et al.*, 2010). Given its design, it provides a snapshot of a given economy, usually for a given year. By convention, it is expected that the total revenue (row account) equals total expenditure (column account). Thus, the SAM explicitly represents the initial equilibrium, or market clearing conditions in the economy, and therefore, can be seen as a baseline measurement of the general equilibrium interactions in the economy for a particular year (Braber *et al.*, 1996).

The 2006 Nigeria's SAM adapted to this study was built for the dynamic CGE model that examined the agriculture growth and investment options for reducing poverty in

[78] This refers to PEP standard CGE model, single country recursive dynamic version

the country (see Nwafor *et al.*, 2010). In its original format, besides other features, the 2006 Nigeria's SAM has 61 productive sectors and 12 household types; however, the SAM was modified to suit the current study. The level of re-aggregation done was motivated by the objectives of the study. In addition, given the interest of this study to analyse the effects of policy (one of which is fuel subsidy removal), a new feature (subsidy on consumption of refined oil) is added to the original SAM. In sum, the current study's SAM has eleven sectors, three factors of production, four household categories, three tax accounts, a firm, government, saving and investment, and rest of the world (ROW) accounts. The subsections that follow presents the structure of the modified SAM for Nigeria used in this study and an analysis of the SAM.[79]

5.2.1 Activities and commodities

A distinction is made between "activity" and "commodity" accounts. The activity accounts correspond to the output-producing sectors in the economy, while the commodity accounts are those goods and services produced by activities. In aggregate, the commodity accounts combine domestic commodity supply with imports to yield total supply to the domestic market or absorption. In this SAM, exports are not included in the "commodity" accounts but sold directly to the "rest of the world" (ROW) by the producers (activities). The SAM has eleven activity sectors, each producing one commodity. Thus, there are eleven commodities accounts. Total production of the each activity sector is derived by the combination of value added (factors of production), and intermediate consumption. Table 5.1 shows not only the code names for activity sectors and their subsectors but their contribution to GDP.

[79] See Nwafor *et al.*, (2010) for a detailed description of the original 2006 SAM from which this version was developed.

Table 5.1. Sectors/subsectors in the Nigeria SAM and their shares in GDP

Code name/ Sector description	Subsectors	GDP (current million Naira)	Share of GDP in 2006 (percent)
Food: comprise six major staples	Rice, Wheat, Maize, Sorghum, Millet, and Cassava	2,401,237.93	12.06
Ocrop: other agricultural crops	Yams, Cocoyams, Irish Potato, Sweet Potato, Banana and Plantain, Beans, Groundnuts, Soyabeans, Beniseed, Vegetables, Fruits, Cocoa, Coffee, Cotton, Oil palm, Sugar and Sugar cane, Unprocessed tobacco, Nuts, Cashew, Rubber, Other crops not specified	2,810,466.25	14.12
Live: livestock	Cattle, live goats and sheep, live poultry, and other livestock	385,580.79	1.94
Otheragr: other agriculture	Fish and fish meat, and forestry	316,364.44	1.59
Man: Manufacturing	Beef, Goat and sheep meat, Poultry meat, Eggs, Milk, Other meat, Beverages, Processed food products, Textiles, Wood, Wood products, furniture, Transportation and other equipment, Other manufacturing	1,315,588.50	6.61
Coil: Crude pretroleum	Crude petroleum	6,860,390.45	34.46
Roil: Refined oil	Refined petroleum	58,157.11	0.29
Omin: Other mining	Other mining	27,191.40	0.14
Transp: Transport	Road transport, Other transportation	472,619.08	2.37
Ser: Services	Building and Construction, Electricity and water, Wholesale and retail trade, Hotel and restaurants, Telecommunications, post, broadcasting, Finance and other business services, Real estate, Education, Health, Other private services	4,345,047.76	21.83
Ntr: Non-tradable	Public Administration	915,888.80	4.60
Total GDP	*Total GDP at Factor Cost*	*19,908,532.53*	*100.00*

Source: Computed by the Author based on modified 2006 Nigeria SAM

(a) Value-added and factors of production

The value-added, also known as "total factor incomes" or "GDP at factor cost" is estimated at N19.91 trillion (Table 5.1). It comprises the total earnings received by the factors of production in the form of rent, wage, and profit (Table 5.2a); thus, there are three production factors (land, labour, and capital). From Table 5.2a, it is clear that with the exception of the extractive industry made up of the crude petroleum, refined petroleum and other mining sectors, other sectors of the economy are labour intensive (with the non-tradable sector being the most labour-intensive sector (99.89%)). Other sectors with high labour intensity are services (83.77%), livestock (72.60%), and other agriculture (70.81%). The transport and food sectors are also labour intensive. The non-tradable sector is thus, the least capital-intensive sector (0.11%) followed by the food (0.19%) and other crop sectors (0.33%). These sectors (food and other crop) are only sectors that employ land in production.

It is interesting to note that although the non-tradable sector is more labour-intensive compared to other sectors, however, its share (10.05%) in total wage bill is less than those paid by the services (40.00%), other crop (17.11%) and food (15.94%) sectors. Also, the profits paid by refined petroleum (0.67%) and other mining (0.29%) sectors are less than those paid by the services (8.18%) and manufacturing (6.90%) sectors.

(b) Intermediate demand

The value of intermediate demand for each activity sector is presented in the Table 5.2b. The Table indicates that non-tradable sector had the highest total intermediate consumption (N2,193.07 billion), followed by services sector (N1,670.54 billion), and then manufacturing sector (N1,402.07 billion). Other mining sector had the least demand for intermediate consumption (N8,660.81 billion). The Table shows that the activity sectors: non-tradable, services, other agriculture, livestock, other crops, and food, depend so much on the intermediate good provided by the services sector. The transport sector has the highest intermediate demand for refined petroleum (45.51%), while the livestock (0.01%) and food (0.03%) sectors had the least. Also, the total intermediate demand for manufactured goods is highest (N1,528.87 billion) compared with other agriculture which is about N24.07 billion.

Table 5.2a. Shares of factors in total value-added in N'billion

Factor	food	ocrop	live	otheragr	man	coil	roil	omin	transp	ser	ntr
Labour	1450862.43 (60.42) [15.94]	1557066.69 (55.40) [17.11]	279939.99 (72.60) [3.08]	224018.91 (70.81) [2.46]	720967.98 (54.80) [7.92]	18713.49 (0.27) [0.21]	689.38 (1.19) [0.01]	2153.89 (7.92) [0.02]	290397.11 (61.44) [3.19]	3639961.75 (83.77) [40.00]	914883.61 (99.89) [10.05]
Capital	4476.29 (0.19) {0.05}	9254.78 (0.33) {0.11}	105640.80 (27.40) {1.23}	92345.53 (29.19) {1.07}	594620.52 (45.20) {6.90}	6841676.96 (99.73) {79.38}	57467.73 (98.81) {0.67}	25037.52 (92.08) {0.29}	182221.98 (38.56) {2.11}	705086.01 (16.23) {8.18}	1005.20 (0.11) {0.01}
Land	945899.22 (39.39)	1244144.77 (44.27)									
TOTAL	***2401237.93***	***2810466.25***	***385580.79***	***316364.44***	***1315588.50***	***6860390.45***	***58157.11***	***27191.40***	***472619.08***	***4345047.76***	***915888.80***

Source: Computed by the Author based on modified 2006 Nigeria SAM

Note: Values in "( )" represents share of factors in total value-added (GDP at factor cost). Those in "[ ]" represents the share of payments (wages) made by economic sectors, while values in "{ }" represents the share of payments (profits) made by sectors out of total wage bill and profit respectively.

Table 5.2b. Intermediate consumption of commodities "I" by the activity sector "J" in N'billion*

Activity (column) / Commodity (row)	food	ocrop	live	otheragr	man	coil	roil	omin	transp	ser	ntr
food	39,297.94 (9.31)		4,342.22 (9.15)		5,697.32 (0.41)					4,280.32 (0.26)	
ocrop		540,24.11 (10.48)	371.62 (0.78)		278,005.26 (19.83)					14,050.14 (0.84)	
live			1,011.72 (2.13)		415,635.55 (29.64)						
otheragr		3,844.07 (0.75)		3,994.82 (4.01)	9,012.78 (0.64)				1,380.28 (0.41)	5,843.99 (0.35)	
man	71,714.03 (16.99)	115,413.71 (22.38)	30.48 (0.06)	3,572.14 (3.58)	181,150.35 (12.92)	286,698.69 (49.20)	35,435.42 (16.57)	2,289.24 (26.43)	142,150.93 (42.31)	406,139.37 (24.31)	284,275.07 (12.96)
coil							120,016.42 (56.11)				
roil	141.24 (0.03)	1,061.61 (0.21)	4.77 (0.01)	1,074.21 (1.08)	34,497.86 (2.46)	73,972.56 (12.69)	12,275.78 (5.74)	2,112.66 (24.39)	152,900.19 (45.51)	267,395.13 (16.01)	208,602.57 (9.51)
omin					46,640.54 (3.33)		19,084.17 (8.92)	2,113.46 (24.40)	4,967.99 (1.48)	51,947.12 (3.11)	
transp			353.64 (0.75)	11,180.89 (11.21)	34,585.96 (2.47)	193,537.23 (33.21)	7,402.04 (3.46)	499.46 (5.77)	5,989.43 (1.78)	206,394.77 (12.35)	432,418.97 (19.72)
ser	310,979.61 (73.67)	341,323.74 (66.19)	41,319.63 (87.11)	79,890.30 (80.12)	396,845.19 (28.30)	28,542.18 (4.90)	19,671.48 (9.20)	1,645.99 (19.01)	28,605.01 (8.51)	714,493.47 (42.77)	1,267,774.66 (57.81)
ntr											
$TOTAL_j$	*422,132.82 (100.00)*	*515,667.24 (100.00)*	*47,434.08 (100.00)*	*99,712.36 (100.00)*	*1,402,070.82 (100.00)*	*582,750.67 (100.00)*	*213,885.31 (100.00)*	*8,660.81 (100.00)*	*335,993.83 (100.00)*	*1,670,544.31 (100.00)*	*2,193,071.21 (100.00)*
$TOTAL_i$	*53617.80*	*346451.13*	*416647.27*	*24075.95*	*1528869.42*	*120016.42*	*754038.58*	*124753.28*	*892362.40*	*3231091.27*	

Source: Computed by the Author based on modified 2006 Nigeria SAM

* Commodities "I" refers to the labels or code names on the row while the activity sectors "J" refers to the labels on the column.

Note: (i) Code names have been defined in Table 13.

(ii) Percentage shares of intermediate consumption of commodities "I" by activity sectors in parenthesis.

(iii) $TOTAL_j$ and $TOTAL_i$ represents the total intermediate consumption by activity sectors (column-sum) and total intermediate demand for commodities "I" (row-sum).

Utilizing information from Table 5.1, 5.2a and 5.2b, the share of value-added and intermediate consumption in total production can be obtained. For instance, it can be deduced that with the exception of manufacturing (0.48%), refined oil (0.21%) and non-tradable (0.29%) sectors, the share of value-added in total output is higher than intermediate consumption.

All these shares have implications on the impact of international commodity price shocks on households. For instance, given the share of intermediate consumption of refined oil in total intermediate demand by the transport sector (45.51%), it is expected that a shock to the price of petroleum would affect the activities of the transport sector more compared to other sectors, and subsequently crude oil and non-tradable sectors would be affected given their high demand for intermediate consumption of the commodity "transport". This transmission continues through the entire system but at varying magnitude (depending on other shares and elasticities).

5.2.2 Domestic supply and export

Recall that in this SAM exports are not included in the "commodity" accounts but sold directly to the ROW by the producers; thus, output is divided between those sold in the domestic market and export market. With the exception of food, livestock, refined petroleum, and non-tradable commodities, all commodities are sold in both markets. Almost all crude petroleum is sold in the export market while about 99% of other crops commodity is sold in the domestic market. About 97% of output from the manufacturing and services sectors are sold in the domestic market.

5.2.3 Domestic Institutions

The SAM contains three domestic institutions: households, firm, and government. The activities (income and expenditure flows) of these institutions are discussed in turn.

(a) Households

In the original SAM there are twelve household categories grouped first according to the six geopolitical zones and then split into urban and rural areas. However, for this study, there are four household categories in the SAM. First, the twelve households were re-aggregated into two (urban and rural households); thereafter, each category was split into poor and non-poor based on the shares obtained from the 2004 Nigerian Living Standard Survey. The categories of the households are, thus, Rural Poor (RP), Rural Non-Poor (RNP), Urban Poor (UP), and Urban Non-Poor (UNP) households. These households' aggregate income (N15,453.20 billion) is made up of factor incomes (N9,099.66 billion - labour income, N10,808.88 billion - capital income[80]) and transfers from other agents (government - N171.78 billion and ROW – N1,359.24 billion, in particular). The percentage shares of each source of income can be seen Figure 5.1a.

From the SAM, basic shares of income from the different sources are obtained. For instance, the share of capital (excluding land income) received by poor and non-poor rural households is very marginal (0.3% and 1.1% respectively) compared to the shares received by urban poor (3.5%) and non-poor (25.6%) households. However, only rural households receive another form of capital income – rent (with the non-poor receiving about 79% of the share). With respect to labour income, urban non-poor households receive the highest share (39.3%) while rural non-poor households receive the least share (13.9%).

Figure 5.1b shows that with the exception of rural non-poor households (whose major source of income is rent), labour income provides the largest share of households' income. Household spend most of their incomes on consumption of commodities and taxes to the government. The SAM shows the different households' consumption across different commodities because their consumption patterns vary. The consumption shares of Nigerian households are captured using Figure 5.2a. From the chart, it is clear that households do not spend their resources on crude petroleum and other mining but spend the bulk of their income on manufactured goods[81], food, and other crops. However, looking at individual household category (Figure 5.2b) it can be seen that food constitutes the largest share in poor households' budget. While rural non-poor households spend the bulk of their income on manufactured goods, urban non-poor households spend more on services.

[80] This capital income includes land.

[81] Manufactured goods also include products from the informal and small-scale manufacturing sector, such as those sold at the roadside (Nwafor *et al.*, 2010).

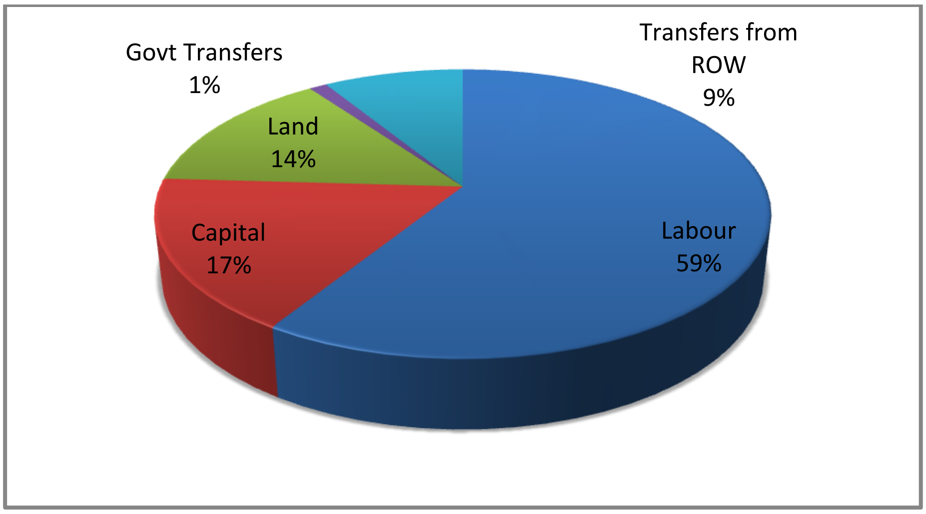
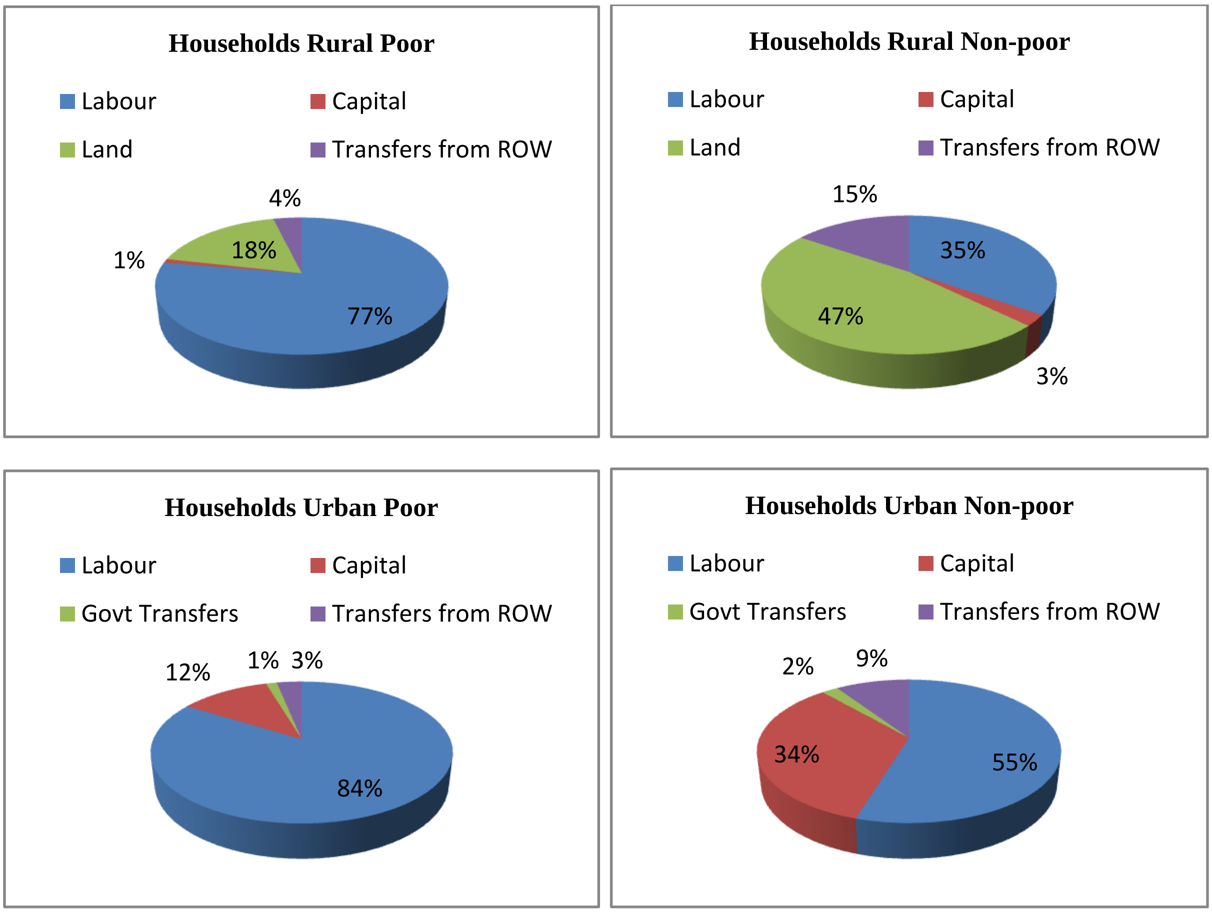


Figure 5.1A. Income sources of Nigerian households



Source: Computed by Author based on modified 2006 Nigeria SAM

Figure 5.1B. Percentage shares of each source of income by household

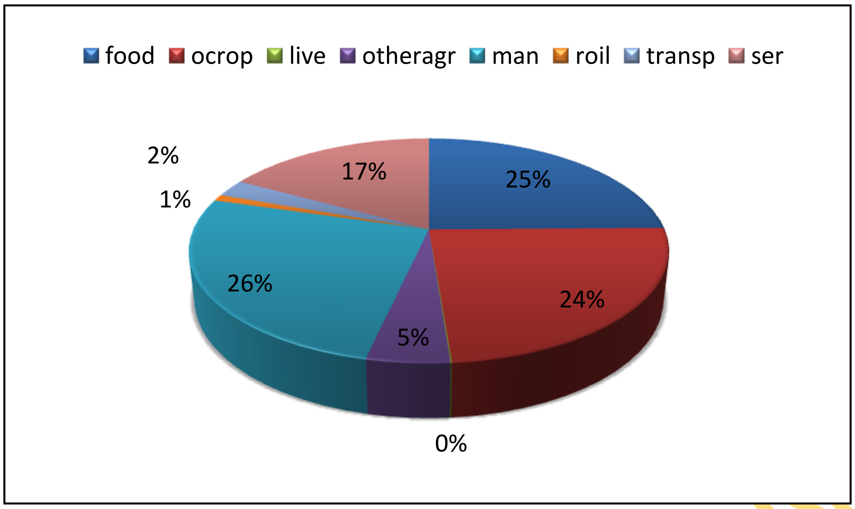
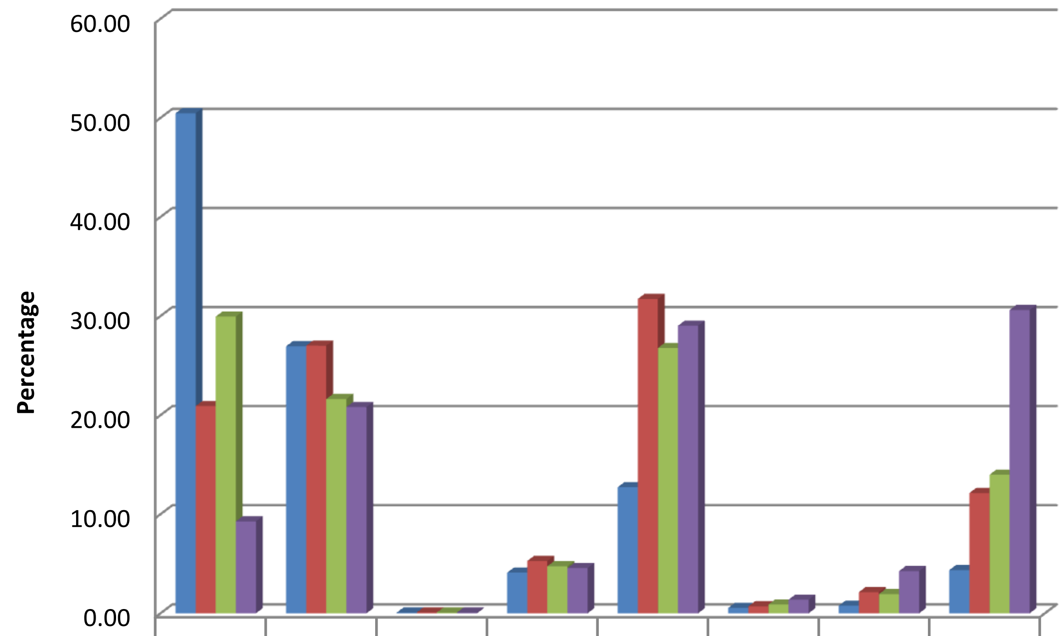


Figure 5.2A. Consumption shares of Nigerian households



	food	ocrop	live	otheragr	man	roil	transp	ser
H-R-P	50.47	26.95	0.07	4.11	12.73	0.54	0.77	4.36
H-R-NP	20.91	27.01	0.09	5.28	31.73	0.70	2.14	12.14
H-U-P	29.95	21.63	0.08	4.75	26.78	0.89	1.94	13.99
H-U-NP	9.28	20.81	0.08	4.57	29.02	1.37	4.26	30.61

Source: Author's drawn based on modified 2006 Nigeria SAM

Figure 5.2B. Consumption share by household category

(b) Firms

The "firms" account included in the Nigeria's SAM is aggregative. Their earned income in the form of profits is distributed to households and government (in the form of taxes). It should be noted that the share of firms' profits received by households has been accounted for in the "capital column". Thus, the value received by the government which appears to be the entire value of firms' profit is only a fraction as it excludes distributions to households. This operation does not alter the result in anyway, save that caution is exercised in the interpretation of changes in the firm account arising from a shock.

(c) Government

The government derives its revenue from taxes, profits from capital, and transfer payments from ROW (such as returns to foreign investments, foreign grants, and development assistance). From these main sources, the share of taxes and profits are 48.56% and 47.87% respectively. Transfer from ROW contributes only a marginal 3.58%. The revenue generated in the from taxes (taxes on production, sales tax, direct and indirect taxes, and import taxes) is N2,800.66 billion. From this lump-sum, the share of direct tax (84.22%) is largest, while the least share (1.84%) is from indirect taxes. A large portion of the direct tax is paid by firms while sales tax on other crops constitutes a large part of taxes on commodities. Also, while government subsidized the production of food and other crop, taxes on services activity is the largest in the composition of activity taxes. The amount of import tax generated from the import of food is the highest among imported commodities.

While observing the different sources of government income and their shares, it is important to understand government expenditure pattern. The SAM shows that government spends its income on consumption of commodities (services – N607.73 billion and non-tradable – N3,108.96 billion), and transfer to households (N171.78 billion). It is also important to note that, unlike Nwafor *et al.*, (2010), the current SAM explicitly accounts for government expenditure on petroleum subsidy. While the expenditures of fuel subsidy in 2006 was estimated to be N261 billion,[82] the computed

[82] See Federal Ministry of Finance, Nigeria; http://www.fmf.gov.ng/component/content/article/3-trendingnews/63-faqfuelsubsidy.html. See also, Adenikinju (2006).

subsidy on import of refined oil was N179 billion.[83] The remaining N82 billion is accounted for by lowered retail crude oil price to domestic refineries and equal sales-price of domestic refined products as the subsidized imported products.[84] Thus, in the SAM, government spends its income on subsidy, which is also reflected as a negative tax on import of refined petroleum.

5.2.4 Rest of the world (ROW) and international trade

The ROW account, also called foreign account, summarizes the economic interactions between the country and other economies in the world. These interactions are in the form of trade (imports and exports), transfers and profits from capital. In the SAM, the total value of imports is N5,146.42 billion with manufactured goods having the highest share of 52.32% (Table 5.3) followed by refined oil (15.24%), then transport and services (each having about 11% and 10% respectively). On the export side, it can be seen that export of crude oil (93.62%) has the largest share in total export while refined oil (0.28%) had the least. Besides its earnings from our imports, the ROW receives capital income (N992.11 billion) given that some capital employed in domestic production is owned by foreign companies. As regards expenditure, ROW spends their income on transfers to other agents (N1,565.58 billion), but more on the purchase of exported commodities (N7,836.67 billion).

5.2.5 Savings and investment

The "savings and investment" account captures the sources of savings that are used to finance domestic investments. Savings in the economy are made up of domestic and foreign savings. Domestic savings include savings from households (N2,539.78 billion) and the government (N1,700.05 billion). Foreign savings reflects the status of the country's current account balance which is estimated at a surplus of N3,263.72 billion. This implies that foreign outflows exceeds foreign inflow; also, that the country's total expenditure (in terms of final consumption and investment demand) is greater than the country's total income.

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[83] Computation was based on information of crude oil export price and retail price for domestic production from the Energy Information Administration, and the Central Bank of Nigeria website www.cenbank.org/rates/crudeoil.asp.

[84] Since the price of crude oil sold to local refineries is less than the export price, the cost of domestic production of refined oil is reduced. This generates an implicit subsidy of domestically produced petroleum and an explicit subsidy on imported products since its sales price is at par with imported refined oil which has been subsidized.

Table 5.3. Nigeria import and export shares (%)

Commodities	Import Shares	Export Shares
Food	4.19	
Other crops	2.04	0.44
Livestock		
Other agriculture	3.00	
Manufactured goods	52.32	1.12
Crude oil	0.03	93.62
Refined oil	15.24	
Other mining	1.98	0.28
Transport	10.94	2.18
Service	10.26	2.36
Total	*100.00*	*100.00*

Source: Author's computation based on modified 2006 Nigeria SAM

5.3 The computable general equilibrium model for Nigeria

CGE models can be regarded as the mathematical equivalents of the transactions represented in the SAM. The model for this study draws from Decaluwe *et al.*, (2010). It is a recursive CGE model adapted to the Nigerian economy based on some peculiar features of the economy as discussed in the SAM section and as in Nwafor *et al.*, (2007). The model does not involve any intertemporal optimization behavioural assumption. Rather, each period is solved as a static equilibrium subject to the variables inherited from the preceding period. Thus, it is possible to separate the *within-period* component from the *between-period* component, where the latter governs the dynamics of the model (see Thurlow, 2008).

This section presents a description of the mathematical statement of the model and their underlying assumptions. Appendix E contains the complete list of the equations, set, variables and parameters.

5.3.1 Model description and linkages[85]

The CGE equation specifications were structured in line with the SAM to show the structure and linkages in the economy. The model has seven blocks which include: production, income and savings, demand, international trade, prices, equilibrium, and dynamic equations blocks. The equations in the model are specified and discussed under these blocks. It is worth pointing out that with the exception of a few modifications made to some equations specification, the current model follows closely the standard PEP 1-t model as developed by Decaluwe *et al.*, (2010).

(a) Production

The model identifies eleven (11) productive sectors or activities. A multi-level cascading specification of the production process is adopted. At the top level, the sectoral output of each productive activity combines value added and aggregate intermediate consumption following a Leontief production function (equations 1 and 2). At the second level (equation 3), each industry's value added is a constant elasticity of substitution (CES) combination of labour and composite capital. It is worth pointing out here that in the extractive sector (made up of crude oil, refined oil, and other mining sectors), a lower substitution between capital and labour is allowed in order to capture the upward trend in both investment and capital stock growth in the sector.

[85] The Figure in Appendix D graphically captures the linkages within and across the various blocks in the model.

Without this treatment, labour demand grows at the expense of capital demand (see Nwafor *et al.*, 2007).

Profit maximization by firms leads them to employ labour and capital to the point where the value of marginal product of each is equal to its price (equation 4). The bottom level on the value added side reveals how the two capital categories (capital and land), can be combined following a CES technology (equation 5). In this study, only the food and other crop sectors combine both types of capital. It is assumed that the different categories of capital are imperfect substitutes. The demand for each type of capital is given by equation 6. On the second level of the intermediate consumption side, total intermediate consumption is made up of various commodities assumed to be perfectly complementary, and combined following a Leontief production function (equation 7).

Producers' supply behaviour is represented by nested constant elasticity of transformation (CET) functions. Producers allocate output among products so as to maximize sales revenue, given product prices (equation 8), by means of a CET. Although an industry can reorganize its production to change the proportion of goods produced in response to price changes, different products are not perfectly transformable to each other. For individual product supply functions (equation 9), they are derived from the first-order conditions of revenue maximizing behaviour.

The resulting equations are:

$$VA_{j,t} = v_j XST_{j,t} \qquad 1.$$

$$CI_{j,t} = io_j XST_{j,t} \qquad 2.$$

$$VA_{j,t} = B_j^{VA}\left[\beta_j^{VA} LD_{j,t}^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KDC_{j,t}^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}} \qquad 3.$$

$$LD_{j,t} = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}} \frac{RC_{j,t}}{W_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t} \qquad 4.$$

$$KDC_{j,t} = B_j^{KD}\left[\sum_{\kappa} \beta_{k,j}^{KD} KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}} \qquad 5.$$

$$KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} RC_{j,t}}{RTI_{k,j,t}} \right]^{\sigma_j^{KD}} \left(B_j^{KD} \right)^{\sigma_j^{KD} - 1} KDC_{j,t} \qquad 6.$$

$$DI_{i,j,t} = aij_{i,j} CI_{j,t} \qquad 7.$$

$$XST_{j,t} = B_j^{XT} \left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho j^{XT}} \right]^{\frac{1}{\rho j^{XT}}} \qquad 8.$$

$$XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT} \right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}} \right]^{\sigma_j^{XT}} \qquad 9.$$

where

$CI_{j,t}$:	Total intermediate consumption of industry *j*
$VA_{j,t}$:	Value added of industry *j*
$XST_{j,t}$:	Total aggregate output of industry *j*
$KDC_{j,t}$:	Industry *j* demand for composite capital
$RC_{j,t}$:	Rental rate of industry *j* composite capital
$W_{j,t}$:	Wage rate of industry *j* labour
$KD_{k,j,t}$:	Demand for type *k* capital by industry *j*
$LD_{j,t}$:	Demand for type *l* labour by industry *j*
$RTI_{k,j,t}$:	Rental rate paid by industry *j* for type *k* capital, including capital taxes
$DI_{i,j,t}$:	Intermediate demand for commodity *i* by business *j*
io_j :	Coefficient (Leontief-intermediate consumption)
v_j :	Coefficient (Leontief-value added)
B_j^{VA} :	Scale parameter (CES-value added)
β_j^{VA} :	Share parameter (CES-value added)
$\beta_{j,i}^{XT}$:	Share parameter (CET-total output)
ρ_j^{VA} :	Elasticity parameter (CES-value added); $-1 < \rho_j^{VA} < \infty$
σ_j^{VA} :	Elasticity of transformation (CES-value added); $0 < \sigma_j^{VA} < \infty$
B_j^{KD} :	Scale parameter (CES-composite capital)
B_j^{XT} :	Scale parameter (CET-total output)
$\beta_{k,j}^{KD}$:	Share parameter (CES-composite capital)
ρ_j^{KD} :	Elasticity parameter (CES-composite capital); $-1 < \rho_j^{KD} < \infty$
σ_j^{KD} :	Elasticity of substitution (CES-composite capital); $0 < \sigma_j^{KD} < \infty$
σ_j^{XT} :	Elasticity of transformation (CET-total output); $0 < \sigma_j^{XT} < \infty$
$aij_{i,j}$:	Input-output coefficient

(b) Income and savings

(b.1) Households

Households are modelled as representative agents that are assumed to have Stone-Geary type of preferences. These households earn their income from labour, capital, and transfers received from other agents (equation 10). Each household category receives a fixed share of the earnings from labour (equations 11). Also, total capital income is distributed among agents in fixed proportions (equation 12), while transfer income is the sum of all transfers received by type h households (equation 13). Type h household disposable income is given by subtracting direct taxes from its total income (equation 14). The portion of disposable income that is left after saving is consumed by households (equation 15). Rather than save a fixed proportion of their total income, household saving is modelled as a linear function of disposable income (equation 16).

$$YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t} \qquad 10.$$

$$YHL_{h,t} = \sum \lambda_h^{WL} \left(W_t \sum_j LD_{j,t} \right) \qquad 11.$$

$$YHK_{h,t} = \sum_k \lambda_{h,k}^{RK} \left(\sum_j R_{k,j,t} RD_{k,j,t} \right) \qquad 12.$$

$$YHTR_{h,t} = \sum_{ag} TR_{h,ag,t} \qquad 13.$$

$$YDH_{h,t} = YH_{h,t} - TDH_{h,t} \qquad 14.$$

$$CTH_{h,t} = YDH_{h,t} - SH_{h,t} \qquad 15.$$

$$SH_{h,t} = PIXCON_t^{\eta} sh0_{h,t} + sh1_h YDH_{h,t} \qquad 16.$$

where

$YH_{h,t}$:	Total income of type h households
$YHK_{h,t}$:	Capital income of type h households
$YHL_{h,t}$:	Labour income of type h households
$YHTR_{h,t}$:	Transfer income of type h households
$R_{k,j,t}$:	Rental rate of type k capital in industry j
$TR_{ag,agj,t}$:	Transfers from agent agj to agent ag
W_t :	Wage rate
$CTH_{h,t}$:	Consumption budget of type h households

$PIXCON_t$: Consumer price index
$SH_{h,t}$: Savings of type *h* households
$TDH_{h,t}$: Income taxes of type *h* households
$YDH_{h,t}$: Disposable income of type *h* households
$\lambda^{TR}_{ag,agj}$: Share parameter (transfer functions)
λ^{WL}_{h} : Share of labour income received by type *h* households
η : Price elasticity of indexed transfers and parameters
$sh0_{h,t}$: Intercept (type *h* household savings)
$sh1_h$: Slope (type *h* household savings)
$agng$: Index of non-government agents;
$agng \in AGNG \subset AG = H \cup F \cup \{ROW\} = \{H_1,...,H_h,...,F,ROW\}$

(b.2) Firms

In this model, firm earns capital income (equation 17). This capital income is only a share of total returns to capital. Firm disposable income (equation 18) is derived by deducting its income taxes from its total income.

$$YF_t = \sum_k \lambda^{RK}_k \left(\sum_j R_{k,j,t} KD_{k,j,t} \right) \qquad 17.$$

$$YDF_{f,t} = YF_{f,t} - TDF_{f,t} \qquad 18.$$

where

$YF_{f,t}$: Total income of firm
$YDF_{f,t}$: Disposable income of firm
$TDF_{f,t}$: Income taxes of firm

(b.3) Government

Government revenue (equation 19) is made up of direct tax revenue from households and firms, indirect taxes on products and on imports, and other taxes on production. It also earns capital income and receives transfers from ROW. The various sources of government revenue are described by equations 20 to 33. It should be noted that income taxes (for households – equation 28, and firms – equation 29) have been modelled as a linear function of total income. With that, the marginal tax rate (which is also time-indexed) is different from the average rate when a non-zero intercept is applied. This proves useful is simulating scenarios in which fiscal policy changes through time.

Government implements two types of taxes on product in this model. The first shows how these taxes are levied on non-imported and imported products (equations 31 and 32, respectively), while the second shows government revenue from import duties on commodities (equation 33).

Government savings (equation 34) is given by the difference between its revenue and expenditure, which comprises consumption of goods and services (taken as fixed), and transfer to other agents, and subsidy on refined oil.

$$YG_t = YGK_t + TDHT_t + TDFT_t + TIPT_t + TPRCTS_t + YGTR_t \qquad 19.$$

$$YGK_t = \sum_k \lambda_{gvt,k}^{RK} \left(\sum_j R_{k,j,t} KD_{k,j,t} \right) \qquad 20.$$

$$TDHT_t = \sum_h TDH_{h,t} \qquad 21.$$

$$TDFT_t = \sum_f TDFT_{f,t} \qquad 22.$$

$$TIPT_t = \sum_j TIP_{j,t} \qquad 23.$$

$$TPRCTS_t = TICT_t + TIMT_t \qquad 24.$$

$$TICT_t = \sum_i TIC_{i,t} \qquad 25.$$

$$TIMT_t = \sum_m TIM_{m,t} \qquad 26.$$

$$YGTR_t = \sum_{agng} TR_{gvt,agng,t} \qquad 27.$$

$$TDH_{h,t} = PIXCON_t^{\eta} ttdh0_{h,t} + ttdh1_{h,t} YH_{h,t} \qquad 28.$$

$$TDF_{f,t} = PIXCON_t^{\eta} ttdf0_{f,t} + ttdf1_t \sum_k \lambda_k^{RK} \left(\sum_j R_{k,j,t} KD_{k,j,t} \right) \qquad 29.$$

$$TIP_{j,t} = ttip_{j,t} PP_{j,t} XS_{j,t} \qquad 30.$$

$$TIC_{nm,t} = ttic_{nm,t} \left(PL_{nm,t} + \sum_i PC_{i,t} tmrg_{i,nm} \right) DD_{nm,t} \qquad 31.$$

$$TIC_{m,t} = ttc_{m,t}\left[\begin{array}{l}\left(PL_{m,t} + \sum_i PC_{i,t}tmrg_{i,m}\right)DD_{m,t} \\ + \left(\left(1 + ttim_{m,t}\right)PWM_{m,t}{}^{e}{}_{t} + \sum_i PC_{i,t}tmrg_{i,m}\right)IM_{m,t}\end{array}\right] \qquad 32.$$

$$TIM_{m,t} = ttim_{m,t}PWM_{m,t^{e}t}IM_{m,t} \qquad 33.$$

$$SG_t = YG_t - \sum_h TR_{h,gvt,t} - G_t - SUB_t \qquad 34.$$

$$SUB_t = TIM_t('roil',t) \qquad 35.$$

where

$DD_{i,t}$:	Domestic demand for commodity *i* produced locally
e_t :	Exchange rate: price of foreign currency in terms of local currency
$EXD_{x,t}$:	World demand for exports of product *x*
G_t :	Current government expenditure on goods and services
$IM_{m,t}$:	Quantity of product *m* imported
$PE_{x,t}$:	Price received for exported commodity *x* (excluding export taxes)
$PL_{i,t}$:	Price of local product *i* (excluding all taxes on products)
$PP_{j,t}$:	Industry *j* unit cost, including taxes directly related to the use of capital and labor, but excluding other taxes on production
$PWM_{m,t}$:	World price of imported product *m* (expressed in foreign currency)
roil:	Refined oil
SG_t :	Government savings
SUB_t :	Subsidy on refined oil
$TDFT_t$:	Total government revenue from firm income taxes
$TDHT_t$:	Total government revenue from household income taxes
$TIC_{i,t}$:	Government revenue from indirect taxes on product *i*
$TICT_t$:	Total government receipts of indirect taxes on commodities
$TIM_{m,t}$:	Government revenue from import duties on product *m*
$TIMT_t$:	Total government revenue from imports duties
$TIP_{j,t}$:	Government revenue from taxes on industry *j* production (excluding taxes directly related to the use of capital and labour)
$TIPT_t$:	Total government revenue from production taxes (excluding taxes directly related to the use of capital and labour)
$TPRCTS_t$:	Total government revenue from taxes on products and imports
YG_t :	Total government income
YGK_t :	Government capital income
$YGTR_t$:	Government transfer income

$ttdf0_{f,t}$: Intercept (income taxes of firm)
$ttdf1_f$: Marginal income tax rate of firm
$ttdh0_{h,t}$: Intercept (income taxes of type *h* households)
$ttdh1_h$: Marginal income tax rate of type *h* households
$ttic_{i,t}$: Tax rate of commodity *i*
$ttim_{m,t}$: Rate of taxes and duties on imports of commodity *m*
$ttip_{j,t}$: Tax rate on the production of industry *j*
$tmrg_{i,ij}$: Rate of margin *i* applied to commodity *ij*
$tmrg^X_{i,x}$: Rate of margin *i* applied to export *x*

(b.4) Rest of the world

The rest of the world receives payments from the value of imports and a share of capital income (equation 36). It expenditure consists of the value of exports and transfer to domestic agents. The difference between foreign receipts and spending is the savings of the rest of the world (equation 37), which are equal to the current account balance, but in opposite sign (equation 38).

$$YROW_t = e_t \sum_m PWM_{m,t} IM_{m,t} + \sum_k \lambda^{RK}_{row,k} \left(\sum_j R_{k,j,t} KD_{k,j,t} \right) \qquad 36.$$

$$SROW_t = YROW_t - \sum_x PE_{x,t} EXD_{x,t} - \sum_{agd} TR_{agd,row,t} \qquad 37.$$

$$SROW_t = -CAB_t \qquad 38.$$

where

CAB_t : Current account balance
$PE_{x,t}$: Exported commodity *x* (in local currency)
$SROW_t$: Rest-of-the-world savings
$YROW_t$: Rest-of-the-world income

(b.5) Transfers

There are two transfer equations in this model: government's transfer (equation 39) to households, and transfers from ROW (equation 40) to domestic agents (households and governments). These transfers are initially set equal to their SAM values, they grow each period at the same rate n_t as population index pop_t, and they are indexed to the consumer price index.

$$TR_{h,gvt,t} = PIXCON_t^{\eta} TR^O_{h,gvt}\, pop_t \qquad 39.$$

$$TR_{agd,row,t} = PIXCON_t{}^{\eta} TR^{O}_{agd,row} pop_t \qquad 40.$$

where

pop_t : Population index

(c) Demand

The demand for commodities (domestically produced and imported), consists of households' and government consumption demand, and investment demand. Households are assumed to have Stone-Geary utility function (which derives from linear expenditure system). As described in the framework it allows for a minimum level of consumption of each commodity. Equation 41 shows that type *h* household demand for each good is determined by utility maximization subject to the budget constraint. Total investment expenditure which includes both private and public investments are distributed among commodities in fixed shares (equations 42 and 43)[86]. The final demand of each commodity *i* for investment purposes is the sum of the quantity demanded for private and public investment (equation 44). Government consumption is given by equation 45. Finally in this block, since goods and services are also used as inputs in the production process, activity sectors demand for investment goods. Thus, the intermediate demand (equation 46) for each commodity is given by the sum of industry demands.

$$C_{i,h,t} PC_{i,t} = C^{MIN}_{i,h,t} PC_{i,t} + \gamma^{LES}_{i,h} \left(CTH_{h,t} - \sum_{ij} C^{MIN}_{ij,h,t} PC_{ij,t} \right) \qquad 41.$$

$$PC_{i,t} INV^{PRI}_{i,t} = \gamma^{INVPRI}_{i} IT^{PRI}_{t} \qquad 42.$$

$$PC_{i,t} INV^{PUB}_{i,t} = \gamma^{INVPUB}_{i} IT^{PUB}_{t} \qquad 43.$$

$$INV_{i,t} = INV^{PRI}_{i,t} + INV^{PUB}_{i,t} \qquad 44.$$

$$PC_{i,t} CG_{i,t} = \gamma^{GOV}_{i} G_t \qquad 45.$$

$$DIT_{i,t} = \sum_{j} DI_{i,j,t} \qquad 46.$$

where

[86] For given amount of investment expenditures (both private and public), the quantity demanded of each commodity *i* for investment purpose is inversely related to its purchaser's price. This also applies to government current expenditure on commodities.

$C_{i,h,t}$: Consumption of commodity *i* by type *h* households

$C^{MIN}_{i,h,t}$: Minimum consumption of commodity *i* by type *h* households

$CG_{i,t}$: Public consumption of commodity *i* (volume)

$DIT_{i,t}$: Total intermediate demand for commodity *i*

$PC_{i,t}$: Purchaser price of composite commodity *i* (including all taxes and margins)

IT^{PRI}_{t} : Total private investment expenditure

IT^{PUB}_{t} : Total public investment expenditure

$INV^{PRI}_{i,t}$: Final demand of commodity *i* for private investment purposes

$INV^{PUB}_{i,t}$: Final demand of commodity *i* for public investment purposes

γ^{LES}_{i} : Marginal share of commodity *i* in type *h* household consumption budget

γ^{GVT}_{i} : Share of commodity *i* in total current public expenditures on goods and services

γ^{INVPRI}_{i} : Share of commodity *i* in total private investment expenditure

γ^{INVPUB}_{i} : Share of commodity *i* in total public investment expenditure

(d) International trade

This block defines the trade relations with the rest of the world. Basically, it describes the behaviour of domestic buyers and producers as regards whether to buy home or imported goods or to sell in the domestic or foreign market. Producers make an optimal distribution of their production between exports and domestic sales according to a CET function (equation 47). For products that are not exported, the total output is equal to supply on the domestic market (equation 48). The world demand for exports is given by equation 50.

As with the producer, on the demand side, the relationship between the rest of the world and the domestic economy is based on the standard *Armington* assumption of imperfect substitution between imports and domestically produced goods. Therefore, buyers assume that local products are imperfect substitutes for imports. This, however, does not hold true for demand of refined oil – where no perfect distinction is made between imports and domestically refined oil. The commodities demanded on the domestic market are combinations of locally produced goods and imports. This assumption is represented by a constant elasticity of substitution (CES) aggregator function (equation 51). However, for goods with no competition for imports, the demand for the composite commodity is the demand for the domestically produced good (equation 52). Finally, buyers maximise expenses, subject to the CES aggregation function; thus, quantity of product *m* imported is given by equation 53.

$$XS_{j,x,t} = B^X_{j,x}\left[\beta^X_{j,x} EX_{j,x,t}^{\rho^X_{j,x}} + \left(1-\beta^X_{j,x}\right) DS_{j,x,t}^{\rho^X_{j,x}}\right]^{\frac{1}{\rho^X_{j,x}}} \quad 47.$$

$$XS_{j,nx,t} = DS_{j,nx,t} \quad 48.$$

$$EX_{j,x,t} = \left[\frac{1-\beta^X_{j,x}}{\beta^X_{j,x}} \frac{PE_{x,t}}{PL_{x,t}}\right]^{\sigma^X_{j,x}} DS_{j,x,t} \quad 49.$$

$$EXD_{x,t} = EXD^O_x\, pop_t \left(\frac{e_t PWX_{x,t}}{PE_{x,t}}\right)^{\sigma^{XD}_x} \quad 50.$$

$$Q_{m,t} = B^M_m\left[\beta^M_m IM_{m,t}^{-\rho^M_m} + \left(1-\beta^M_m\right) DD_{m,t}^{-\rho^M_m}\right]^{\frac{-1}{\rho^M_m}} \quad 51.$$

$$Q_{nm,t} = DD_{nm,t} \quad 52.$$

$$IM_{m,t} = \left[\frac{\beta^M_m}{1-\beta^M_m} \frac{PD_{m,t}}{PM_{m,t}}\right]^{\sigma^M_m} DD_{m,t} \quad 53.$$

where

$XS_{j,i,t}$:	Industry *j* production of commodity *i*
$DS_{i,j}$:	Supply of commodity *i* by sector *j* to the domestic market
$EXD_{x,t}$:	World demand for exports of product *x*
$P_{j,i,t}$:	Basic price of industry *j*'s production of commodity *i*
$PD_{i,t}$:	Price of local product *i* sold on the domestic market (including all taxes and margins)
$PE_{x,t}$:	Price received for exported commodity *x* (excluding export taxes)
$PM_{m,t}$:	Price of imported product *m* (including all taxes and tariffs)
$PWX_{x,t}$:	World price of exported product *x* (expressed in foreign currency)
$Q_{i,t}$:	Quantity demanded of composite commodity *i*
B^M_m :	Scale parameter (CES-composite commodity)
β^M_m :	Share parameter (CES-composite commodity)
$B^X_{j,x}$:	Scale parameter (CET-exports and local sales)
B^{XT}_j :	Scale parameter (CET-total output)
$\beta^X_{j,x}$:	Share parameter (CET-exports and local sales)
$\beta^{XT}_{j,i}$:	Share parameter (CET-total output)
ρ^M_m :	Elasticity parameter (CES-composite commodity); $-1 < \rho^M_m < \infty$
$\rho^X_{j,x}$:	Elasticity parameter (CET-exports and local sales); $-1 < \rho^X_{j,x} < \infty$

ρ_j^{XT} : Elasticity parameter (CET-total output); $-1 < \rho_j^{XT} < \infty$

σ_m^M : Elasticity of substitution (CES-composite commodity); $0 < \sigma_m^M < \infty$

$\sigma_{j,x}^X$: Elasticity of transformation (CET-exports and local sales); $0 < \sigma_{j,x}^X < \infty$

σ_x^{XD} : Price-elasticity of the world demand for exports of product x

σ_j^{XT} : Elasticity of transformation (CET-total output); $0 < \sigma_j^{XT} < \infty$

(e) Prices

In this block, there are three categories of prices. Prices related to production, international trade and price indexes. The price equations are discussed under these categories.

(e.1) Production

In aggregation, the price of an aggregate is the weighted sum of the prices of its component. Thus, the unit cost of an industry's output is a weighted sum of the prices of value added and aggregate intermediate consumption (equation 54). The same principle applies to the prices of other aggregates (equations 56 and 57). The price of composite capital of an industry is a weighted sum of the rental rates of the different types of capital used by that industry is given by equation 58. The basic price of production is obtained from the unit cost by adding taxes on production (equation 55).

$$PP_{j,t} = \frac{PVA_{j,t} VA_{j,t} + PCI_{j,t} CI_{j,t}}{XST_{j,t}} \qquad 54.$$

$$PT_{j,t} = (1 + ttip_{j,t}) PP_{j,t} \qquad 55.$$

$$PCI_{j,t} = \frac{\sum_i PC_{i,t} DI_{i,j,t}}{CI_{j,t}} \qquad 56.$$

$$PVA_{j,t} = \frac{WC_{j,t} LDC_{j,t} + RC_{j,t} KDC_{j,t}}{VA_{j,t}} \qquad 57.$$

$$RC_{j,t} \frac{\sum_k RTI_{k,j,t} KD_{k,j,t}}{KDC_{j,t}} \qquad 58.$$

where

$PT_{j,}$: Basic price of industry j's output

$PVA_{j,t}$: Price of industry j value added (including taxes on production directly related to the use of capital and labour)

$PCI_{j,t}$: Intermediate consumption price index of industry j

(e.2) International trade

For exporting countries, the price of their aggregate production is a weighted sum of the price obtained in the domestic market and international market, based on the price aggregation principle. The weight assigned to each market (which varies in response to relative price changes or on the elasticity of transformation) is proportional to the quantity sold on the market (equation 59). Equation 60 which describes the basic price obtained by industry j for exportable product x is a weighted sum of its basic price on the domestic market and its basic price on the export market. The price for products not exported by an industry is the domestic market price (equation 61).

Recall that commodities purchased on the domestic market are composites. Thus, while the price paid for the local commodities is the sum of the price received by the producer, and indirect taxes (equation 62), the price paid for imported commodity is the international price (translated into local currency) plus taxes and duties on import, and domestic indirect taxes (equation 63). However, for commodities facing import competition, the price of the composite is a weighted sum of the price paid domestically produced and imported goods (equation 64). For commodities facing no competing import, the price of commodities is the price paid for the local product (equation 65).

$$PT_{j,t} = \frac{\sum_i P_{j,i,t} XS_{j,i,t}}{XST_{j,t}} \qquad 59.$$

$$P_{x,t} = \frac{PE_{x,t} EX_{x,t} + PL_{x,t} D_{x,t}}{XS_{x,t}} \qquad 60.$$

$$P_{nx,t} = PL_{nx,t} \qquad 61.$$

$$PD_{i,t} = \left(1 + ttic_{i,t}\right) PL_{i,t} \qquad 62$$

$$PM_{m,t} = \left(1 + ttic_{m,t}\right)\left(\left(1 + ttim_{m,t}\right) e_t PWM_{m,t}\right) \qquad 63.$$

$$PC_{m,t} = \frac{PM_{m,t} IM_{m,t} + PD_{m,t} D_{m,t}}{Q_{m,t}} \qquad 64.$$

$$PC_{nm,t} = PD_{nm,t} \qquad 65.$$

(e.3) Price Indexes

The indexes are the GDP deflator (Fisher index) (equation 66), the consumer price index (Laspeyres index) (equation 67).

$$PIXGDP_t \sqrt{\frac{\sum_j PVA_{j,t} VA_j^O \sum_j PVA_{j,t} VA_{j,t}}{\sum_j PVA_j^O VA_j^O \sum_j PVA_j^O VA_{j,t}}} \qquad 66.$$

$$PIXCON_t = \frac{\sum_i PC_{i,t} \sum_h C_{i,h}^O}{\sum_{ij} PC_{ij}^O \sum_h C_{ij,h}^O} \qquad 67.$$

where

$PIXGDP_t$: GDP deflator

(f) Equilibrium

This block presents the equations that describe equilibrium in the different markets. Equilibrium between the supply of and demand for each commodity on the domestic market is defined by equation 68. This equation aids the verification of Walras law which states that if *n-1* markets are in equilibrium then the last market is also in equilibrium. Equations 69 and 70 define equilibrium in the factor market for labour and capital respectively. Also, as part of the equilibrium condition, it is expected that total investment expenditure equals the sum of agents' savings (equation 71) and that the different forms of investment expenditure equals total investment (equation 72). In addition, the sum of supplies of every commodity by local producers must be equal to domestic demand for that commodity produced locally (equation 73), and the supply and demand for exportable goods must be equal (equation 74).

$$Q_{i,t} = \sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + DIT_{i,t} \qquad 68.$$

$$\sum_j LD_{j,t} = LS_t \qquad 69.$$

$$\sum_j KD_{k,j,t} = KS_{k,t} \qquad 70.$$

$$IT_t = \sum_h SH_{h,t} + SG_t + SROW \qquad 71.$$

$$IT_t^{PRI} = IT_t - IT_t^{PUB} \qquad 72.$$

$$\sum_{j} DS_{j,i,t} = DD_{i,t} \qquad 73.$$

$$\sum_{j} EX_{j,x,t} = EXD_{x,t} \qquad 74.$$

where

LS_t :	Supply of labour
$KS_{k,t}$:	Supply of type *k* capital
IT_t :	Total investment expenditure

GDP (equation 75) computed is not an equilibrium condition. It is made up of payments to factors, plus taxes on production, and taxes on products and imports

$$GDP_t = \sum_{j} PVA_{j,t} VA_{j,t} + TIPT_t + TPRCTS_t \qquad 75.$$

where

GDP_t : Gross Domestic Product

(g) Dynamic Equations

The dynamic equations describe the between-period relationships in the model. The first driver of dynamics in the model is 'population' captured by a population index pop_t, assumed to grow each period at a rate n_t. Thus, we have $pop_t = pop_{t-1}(1+n_{t-1})$. This is used in the model to update the values of variables and parameters that are assumed to grow at that rate. The variables include labour supply, current account balance, minimum consumption of commodities in the LES demand system, government current expenditures, and public investment. The parameters assumed to grow at the same rate n_t are household savings function intercept, the households' and firm income tax function intercepts, and transfers from government and from the rest of the world.[87]

The dynamic equations include capital accumulation (equation 76) which shows that the stock of type *k* capital in industry *j* in period *t* + 1 is equal to the stock of the preceding period minus depreciation plus the volume of new capital investment in the preceding period. Equation 77 describes the amount of public investment expenditures.

[87] Decaluwe *et al.*, (2010) explains that the reason for assuming that constants and exogenous variables grow at the same rate as labour supply is to make it possible for the model to simulate a balanced growth path – a rather unrealistic scenario. They however, argued that it proves useful as a "business-as-usual" (BAU) scenario or to test model consistency.

The equation determines how much savings are utilized for public investment, and given the price of private investment, the volume of new private capital investment is constrained by equation 78. Equations 79 and 80 give the prices of new private and public capital. Finally, the volume of new type *k* capital allocated to private / business-sector industry *bus* is proportional to the existing stock of capital (equation 81). This proportion varies from the ratio of the rental rate to the user cost of that capital (equation 82), which is interpreted as Tobin's *q*. The user cost of capital depends on the price of new capital, the rate of depreciation, and the rate of interest.

$$KD_{k,j,t+1} = KD_{k,j,t}\left(1-\delta_{k,j}\right) + IND_{k,j,t} \quad 76.$$

$$IT_t^{PUB} = PK_t^{PUB} \sum_{k,pub} IND_{k,pub,t} \quad 77.$$

$$IT_t^{PRI} = PK_t^{PRI} \sum_{k,bus} IND_{k,bus,t} \quad 78.$$

$$PK_t^{PRI} = \frac{1}{A_{bus}^k} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}} \quad 79.$$

$$PK_t^{PUB} = \frac{1}{A_{pub}^k} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}} \quad 80.$$

$$IND_{k,bus,t} = \phi_{k,bus}\left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t} \quad 81.$$

$$U_{k,bus,t} = PK_t^{PRI}\left(\delta_{k,bus} + IR_t\right) and U_{k,pub,t} = PK_t^{PUB}\left(\delta_{k,pub} + IR_t\right) \quad 82.$$

where

$IND_{k,j,t}$:	Volume of new type *k* capital investment to sector *j*
$IND_{k,bus,t}$:	Volume of new type *k* capital investment to private business sector *bus*
IR_t :	Interest rate
PK_t^{PRI} :	Price of new private capital
PK_t^{PUB} :	Price of new public capital
$U_{k,j,t}$:	User cost of type *k* capital in industry *j*
A_{bus}^K :	Scale parameter (price of new private capital)
A_{pub}^K :	Scale parameter (price of new public capital)
$\delta_{k,j}$:	Depreciation rate of capital *k* used in industry *j*
$\phi_{k,j}$:	Scale parameter (allocation of investment to industries)

σ_j^{KD} : Elasticity of substitution (CES-composite capital); $0 < \sigma_j^{KD} < \infty$

5.3.2 Closure rule

As highlighted in the closure rule subsection of the literature review, the equilibrium results of the model and their implications with respect to policy analysis depend on how the model is closed. Thus, deciding which prices and quantities to be made exogenous so as to derive a square system in the model is important as it defines the direction of causality in the model.[88] In the current study the choice of closure is informed by economic considerations as well as the context of the analysis. The underlying assumptions and implemented closure rule applied in the model include:

Factor market closure

Labour supply is held fixed and assumed to be mobile across sectors; thus, wage is allowed to adjust to clear the market (neoclassical closure)[89]. On the other hand, capital is fixed in the first period but mobile afterwards; thus, return to capital is determined endogenously in the model to clear the market for capital supply.

Goods market closure

Equilibrium in the goods market requires that the demand for commodities equal supply. This equilibrium is attained through the endogenous interaction of domestic and foreign prices, the effects that shifts in relative prices have on sectoral production and employment, and hence institutional incomes and demand.

Macroeconomic closures

Macro closures determine how macro-equilibrium is reached after a shock; therefore, it is necessary to specify a set of 'macro-closure' rules. The model includes three broad macroeconomic accounts: the current account, the government balance, and the savings and investment account.

In the model, the nominal exchange rate is chosen as *numeraire*. Thus, changes in domestic price indices can be interpreted as changes in domestic prices relative to international prices which have been fixed in the model. Given that nominal exchange rate is treated as exogenous, the current account is fixed directly, and foreign savings is allowed to adjust endogenously to ensure external balance. It has been argued that

[88] Mathematically, ensuring that a model is 'closed' or deriving a square system amounts to ensuring that there are as many independent equations to explain the endogenous variables.

[89] An alternative specification with unemployment was also considered. The results are reported in Appendix H.

measures of economic welfare based on household consumption become invalid if the current account is free (since borrowing funds increases consumption in the current period, and no provision is made in the model for paying the debt back).

In the government account, the government expenditure is fixed in real terms, as well as all tax rates. As a result, the balance on the government budget is assumed to adjust to ensure that public expenditures equal revenue.

As regards savings-investment closure, the model adopts a savings-driven closure, in which the saving rates of domestic institutions are fixed, and investment passively adjusts to ensure that savings rate equals investment spending in equilibrium. This is unlike the more Keynesian view which reverses the causality found in neoclassical theory by arguing that investment is exogenous and that savings adjust to clear the market. Arguably, as most households in Nigeria are poor and more unlikely to increase savings in order to fund future investment, a savings-driven closure appears more appropriate for this study.

5.4 Description of simulation scenarios

The study focuses on the impact of shocks to the international prices of refined oil and food taking place between 2006 and 2008. The analysis is performed under different scenarios and simulation experiment as discussed below.

(i) Scenario one (food price shock)

This scenario considers the effect of food price shock. One simulation (S1FOOD) which captures the effects of a 37% increase in the international price of food was conducted.[90] This represents the percentage change in food price between 2006 and 2007 (see IMF 2011).

(ii) Scenario two (oil price shock)

In this scenario the effects of oil price shock is considered. Two simulations were conducted: the first (S2OIL1) considers a 60% increase in the price of refined oil.[91] The second simulation (S2OIL2) considers a 37% increase in the refined oil. The "thought experiment" explored through S2SIM2 considers what would have happened if the economy experienced the same price increase as food.

[90] It should be noted that this percentage increase reflect changes in the price of major cereals as captured in the definition of food as used in this study (see page 79).
[91] This represents the percentage difference between refined oil price proxied by gasoline between mid 2006 and 2008 (see Index Mundi, and U.S Energy Information Administration).

(iii) Scenario three (combined oil price and food price shocks)

In this scenario one simulation is carried out, and it focuses on the effects of a combined oil price and food price shocks. Specifically, it considers S1FOOD (a 37% increase in the price of food) and S2OIL1 (a 60% increase in the international price of oil). This scenario (S3SIM) tries to mimic the experience of many economies of the world in recent past.

Overall, the objective of the simulations is to reasonably capture the shocks in international commodity prices that occurred between 2006 and 2008. This satisfies the first specific objective of this study. Objective 2 is achieved by carefully considering the channels through which the shocks are transmitted to households in Nigeria under the different simulation experiments (particularly, S1FOOD and S2OIL1). To address objective 3, the study considers one more scenario as discussed hereunder.

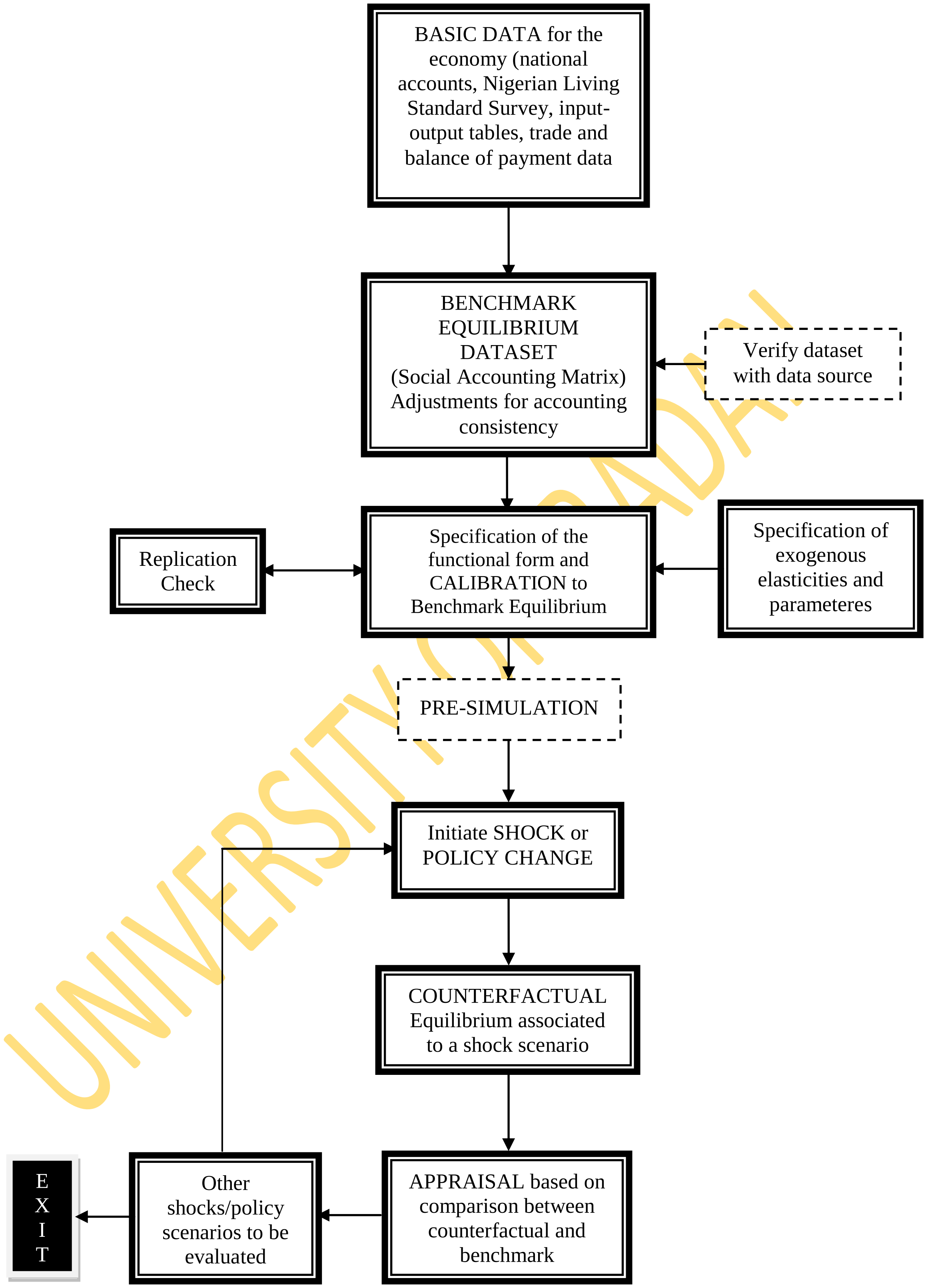
(iv) Scenario four (fiscal policy response / shock)

In this scenario three simulations were conducted. The first, (S4FOOD) considers an actual 50% reduction in import tax of food. This was applied in S1FOOD. The Federal Government in 2008 implemented a 50% import tax reduction on rice (see CBN, 2008). Although, the import tax reduction was only on the import of rice, in the simulation experiment it was applied on the commodity "food" which comprises six major staples. This poses no real challenge since the percentage of rice in total imports of "food" is largest. The second, (S4OIL) is broken into two: S4OILa which considers a complete elimination of subsidy on refined oil; and S4OILb which considers a gradual reduction of subsidy on refined oil over the simulation period. Specifically, it considers an additional 10% decrease each period after an initial 60% reduction was implemented in the first period following the shock. These simulations were applied under S2OIL1.

5.5 Calibration and implementation of the CGE model

The implementation of the CGE model involves several steps. The first step required setting up the structure of the model. To do this, the required dataset for the economy had to be collected. However, given that the current study adapted an existing dataset, the process was modified to verifying the dataset with their data source, leading to the benchmark equilibrium dataset. Thereafter, a functional form was chosen for the production and demand functions. The final stage in operationalizing the CGE model required deriving parameter values for the functional forms. The most commonly used procedure to determine the parameter values is calibration. Calibration involves choosing the values of a subset of the parameters in such a way that, together with the assembled SAM and the values of the behavioural parameters, the model reproduces the initial data set of the reference year. An alternative is to estimate such parameters empirically. However, besides the high-level sophistication of econometric technique required, most of the required time-series or even cross-sectional series data are rarely available. Therefore, to obtain the model's parameter estimates, information contained in the SAM itself was utilized. The parameters that were calibrated are share and scale parameters. It was supplemented with elasticity parameters (which describes the curvature of various structural functions like production, utility, export supply, import demand functions) obtained from additional sources such as Nwafor *et al.*, 2007, and Dorosh, 1996.

After the replication check which verifies that the model specification and the calibration exercise are correct, turned out the exact data set as the reference year, the data of the SAM together with the characterizing equations of the model was taken to be a solution to the model. Once the replication check is done, the simulation experiments (as described in the previous section) were executed. All simulations of the CGE model were based on a comparison with the baseline. Figure 5.3 provides a schematic representation of the steps followed in implementing the model.



Source: Adapted from WTO and UNCTAD, 2012

Figure 5.3. Steps followed in implementing the CGE model

5.6 Concluding remarks

In this chapter, the SAM which serves as benchmark data for the implementing the CGE model is described. It was based on the 2006 Nigeria SAM. The SAM was modified to comprise eleven productive sectors, four representative households and other economic agents, and was made to account explicitly for petroleum subsidy. In addition, the database serves the purpose of calibration for determining parameter values. The CGE model adapted for the study was based on the PEP-1t model; it was, however, structured in line with the SAM and modified to account for some peculiar features of the Nigerian economy. The model does not involve any intertemporal optimization behavioural assumption but a series of static equilibrium to be solved sequentially. Thus, it is possible to separate the within-period component from the between-period component. The closure rule, which defines the direction of causality in the model, was highlighted. A set of simulation scenarios was described. They include scenarios of food and oil price shocks, a combined food and oil price shock, and tax and fuel subsidy policy reform. Finally, the procedure in implementing the CGE model was described.

CHAPTER 6

PRESENTATION AND DISCUSSION OF RESULTS

6.1 Introduction

This chapter presents and discusses the sets of results obtained from the simulation experiments. The discussion centres on households' effects, however, discussions are extended to include some key sectoral-level variables given their roles in driving the overall impacts of the shocks on households. The discussions, finally extends to some macroeconomic implications of the shocks.

Consequently, this chapter is organised as follows. In Section 6.2, the households' effects of food and oil price shocks are presented and discussed. Specifically, the simulation results discussed are scenario one and two as described in section 5.4 of the preceding chapter. Results of the combined food and oil price shock scenario are discussed in Section 6.3. The transmission mechanisms of the shocks to households are presented in Section 6.4. Section 6.5 captures how a reduction in import tax on food aimed at mitigating the effect of food price shock affects the households. In addition, the section considers how a policy reform - removal of petroleum subsidy in the energy market changes the effects of oil price shock. The final section concludes the chapter.

6.2 Food and Oil Price Shocks

The discussion starts with the food price shock scenario, oil price shock scenario is presented afterwards. Although, in the discussion, mention is made on some specific periods' effects, however, for ease of interpretation, emphasis is on average effects over the simulation period. Under each simulation, percentage changes relative to the base year value are presented and discussed for ease of appreciation and comprehension. Also, discussions on households' effects in this study are with respect to their income and consumption. In discussing these effects, it is necessary to recall that as part of the closure rule, household saving rates and the current account balance are fixed and investment is allowed to adjust to clear the market. Also, all household tax rates are assumed to be fixed. In addition, the model captures the changes that occur in labour and capital income sources through the differential impacts observed at the industry level. Albeit, the household total income flows are determined by taking into account the changes in wage income, capital income and transfer income from government and ROW. Moreover, accounting for the household tax payments generates the change in disposable income for different household group over the base case.

6.2.1 Food Shock Scenario

(i) Income Effects

Table 6.1 shows that a 37% shock to the international price of food increased total household income by 2.4%, 2.9%, 1.9% and 1.5% for rural poor, rural non-poor, urban poor and urban non-poor households respectively. The positive income effects from the increase in the world food price manifest themselves primarily through the production response. With the mobility of factors, domestic (agricultural) production is reallocated towards food crops, particularly those whose international prices are rising, permitting a greater demand for home-grown food. As expected, with an increase in the international price of a commodity, the final market price of that commodity in the domestic economy increases (given that there are no trade distortions such as subsidy or lowering of tariffs on that commodity). Consequently, due to the variation in the relative price of domestic (PD_f) and imported food (PM_f) (see Appendix E1 Tables F and I), there is a shift in demand from food imports to domestic food. Table 6.2A shows that food imports declined by about 41% on average, while Table 6.2B indicates an expansion in domestic food production by 3.93% on average. Other imported commodities such as other crop, livestock, manufacturing, transport and services also experience increase ranging between 0.47% for the transport commodity and 3.19% for other crops commodity. Consequently, there was a decline in the domestic supply of these commodities.

The increase in domestic food production evidenced in this study corroborates the finding of Nkang *et al.*, (2013). They also find an expansion in domestic food production but by 5.2% following a 50% shock to the international price of food. The difference in the magnitude of impact may be attributed to the size of the shock they considered and the number of agricultural sub-sectors that made up their food sector (which extends beyond the six major staples considered in this study).

Table 6.1. Households' income effects of food price shock

	Total income of type *h* households (YH)							
	RP		RNP		UP		UNP	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,641,967	2.51	3,647,130	2.98	2,631,358	2.02	6,532,744	1.59
2	2,721,226	2.44	3,756,544	2.92	2,710,299	1.95	6,728,727	1.53
3	2,802,863	2.38	3,869,240	2.88	2,791,608	1.89	6,930,589	1.48
4	2,886,949	2.32	3,985,317	2.83	2,875,356	1.83	7,138,506	1.43
5	2,973,557	2.27	4,104,877	2.79	2,961,617	1.77	7,352,661	1.38
Av	*2,805,312*	***2.38***	*3,872,622*	***2.88***	*2,794,048*	***1.89***	*6,936,645*	***1.48***
	Capital income of type *h* households (YHK)							
	RP		RNP		UP		UNP	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	491,906	3.57	1,817,510	3.57	304,086	0.16	2,209,020	0.16
2	506,663	3.55	1,872,036	3.55	313,208	0.15	2,275,290	0.15
3	521,863	3.53	1,928,197	3.53	322,605	0.13	2,343,549	0.13
4	537,519	3.51	1,986,043	3.51	332,283	0.1	2,413,856	0.1
5	553,644	3.48	2,045,624	3.48	342,251	0.08	2,486,271	0.08
Av	*522,319*	***3.53***	*1,929,882*	***3.53***	*322,887*	***0.12***	*2,345,597*	***0.12***
	Labour income of type *h* households (YHL)							
	RP		RNP		UP		UNP	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,050,795	2.24	1,267,110	2.24	2,206,290	2.24	3,575,461	2.24
2	2,112,319	2.16	1,305,123	2.16	2,272,478	2.16	3,682,725	2.16
3	2,175,689	2.1	1,344,277	2.1	2,340,653	2.1	3,793,206	2.1
4	2,240,959	2.03	1,384,605	2.03	2,410,872	2.03	3,907,003	2.03
5	2,308,188	1.98	1,426,143	1.98	2,483,198	1.98	4,024,213	1.98
Av	*2,177,590*	***2.1***	*1,345,452*	***2.1***	*2,342,698*	***2.1***	*3,796,522*	***2.1***
	Transfer income of type *h* households (YHTR)							
	RP		RNP		UP		UNP	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	99,266.46	2.7	562,509.92	2.7	120,982.68	2.7	748,263.76	2.7
2	102,244.45	2.61	579,385.22	2.61	124,612.16	2.61	770,711.67	2.61
3	105,311.78	2.53	596,766.78	2.53	128,350.53	2.53	793,833.02	2.53
4	108,471.14	2.46	614,669.78	2.46	132,201.04	2.46	817,648.01	2.46
5	111,725.27	2.39	633,109.88	2.39	136,167.07	2.39	842,177.46	2.39
Av	*105,403.82*	***2.54***	*597,288.32*	***2.54***	*128,462.70*	***2.54***	*794,526.78*	***2.54***
	Disposable income of type *h* households (YDH)							
	RP		RNP		UP		UNP	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,641,967	2.51	3,647,130	2.98	2,616,184	2.02	6,422,513	1.59
2	2,721,226	2.44	3,756,544	2.92	2,694,670	1.95	6,615,189	1.53
3	2,802,863	2.38	3,869,240	2.88	2,775,510	1.89	6,813,644	1.48
4	2,886,949	2.32	3,985,317	2.83	2,858,775	1.83	7,018,054	1.43
5	2,973,557	2.27	4,104,877	2.79	2,944,538	1.77	7,228,595	1.38
Av	*2,805,312*	***2.38***	*3,872,622*	***2.88***	*2,777,935*	***1.89***	*6,819,599*	***1.48***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.2A. Quantity of product imported (IM)

	FOOD		OCROP		LIVE	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	215,567.33	-40.69	105,017.35	3.49	88.39	2.94
2	222,034.35	-40.85	108,167.87	3.32	91.04	2.81
3	228,695.38	-40.99	111,412.91	3.17	96.3	2.69
4	235,556.24	-41.12	114,755.30	3.04	96.58	2.58
5	242,622.93	-41.24	118,197.96	2.91	99.48	2.46
Av	*228,895.25*	***-40.98***	*111,510.28*	***3.19***	*94.36*	***2.70***
	MAN		**COIL**		**ROIL**	
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,692,373.35	2.14	1,353.64	-0.17	784,233.43	-0.91
2	2,773,144.55	2.06	1,394.25	-0.78	807,760.43	-0.75
3	2,856,338.88	1.98	1,436.08	-1.08	831,993.25	-0.65
4	2,942,029.05	1.90	1,479.16	-1.21	856,953.04	-0.59
5	3,030,289.92	1.82	1,504.63	0.00	882,661.64	-0.56
Av	*2,858,835.15*	***1.98***	*1,433.55*	***-0.65***	*832,720.36*	***-0.69***
	TRANSP		**SER**			
T	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD		
1	563,244.00	0.5	528,127.84	2.94		
2	580,141.32	0.49	543,971.68	2.82		
3	597,545.56	0.47	560,290.83	2.71		
4	615,471.92	0.45	577,099.55	2.6		
5	633,936.08	0.43	594,412.54	2.51		
Av	*598,067.78*	***0.47***	*560,780.49*	***2.72***		

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.2B. Total aggregate output (XST)

T	FOOD		OCROP		LIVE		OTHERAGR	
	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,821,815.80	3.73	3,323,270.57	-0.42	440,653.47	-1.04	420,401.17	-1.00
2	2,906,470.28	3.84	3,422,968.69	-0.38	453,873.08	-0.99	433,013.20	-0.93
3	2,993,664.39	3.94	3,525,657.75	-0.34	467,489.27	-0.95	446,003.60	-0.88
4	3,083,474.32	4.03	3,631,427.49	-0.30	481,513.95	-0.93	459,383.70	-0.83
5	3,175,978.55	4.10	3,740,370.31	-0.28	495,959.37	-0.91	473,165.22	-0.79
Av	*2,996,280.67*	***3.93***	*3,528,738.96*	***-0.34***	*467,897.83*	***-0.96***	*446,393.38*	***-0.89***

T	MAN		COIL		ROIL		OMIN	
	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	2,729,185.77	-1.11	7,455,559.84	-0.01	275,325.59	-0.09	35,852.22	-0.31
2	2,811,061.35	-1.05	7,679,226.64	-0.05	283,585.36	-0.44	36,927.78	-0.38
3	2,895,393.19	-1.00	7,909,603.43	-0.11	292,092.92	-0.64	38,035.62	-0.45
4	2,982,254.98	-0.97	8,146,891.54	-0.17	300,855.71	-0.77	39,176.69	-0.52
5	3,071,722.63	-0.95	8,391,298.28	-0.23	309,881.38	-0.85	40,351.99	-0.60
Av	*2,897,923.58*	***-1.02***	*7,916,515.95*	***-0.11***	*292,348.19*	***-0.56***	*38,068.86*	***-0.45***

T	TRANSP		SER		NTR	
	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD	BAU N' Million	S1FOOD
1	822,836.49	-1.70	6,111,682.71	-0.79	3,108,960.07	-1.47
2	847,521.58	-1.66	6,295,033.19	-0.76	3,202,228.87	-1.42
3	872,947.23	-1.62	6,483,884.18	-0.74	3,298,295.74	-1.38
4	899,135.65	-1.59	6,678,400.71	-0.72	3,397,244.61	-1.33
5	926,109.72	-1.56	6,878,752.73	-0.71	3,499,161.95	-1.29
Av	*873,710.13*	***-1.63***	*6,489,550.70*	***-0.74***	*3,301,178.25*	***-1.38***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

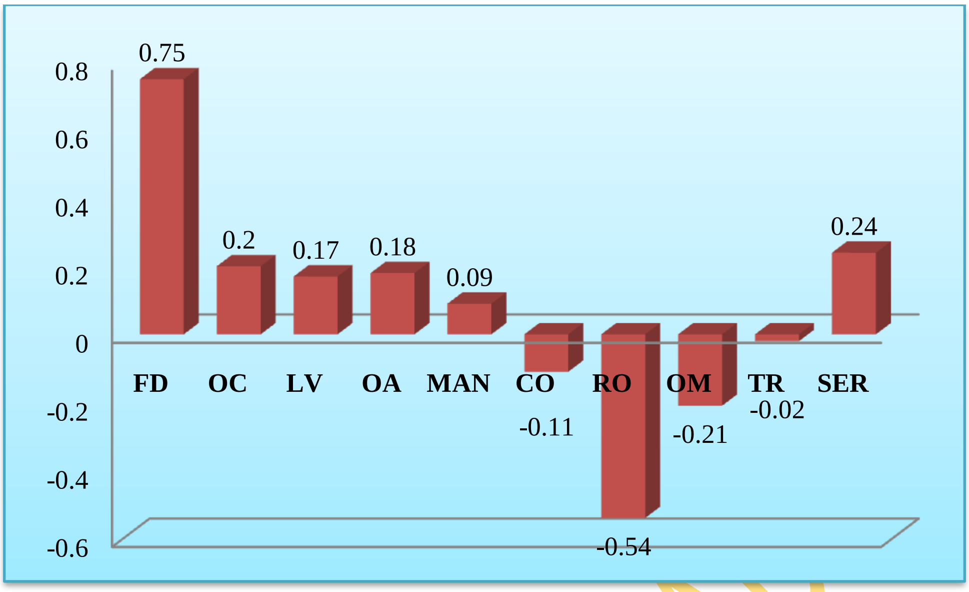
The increased demand for home-grown food stimulated demand for productive factors in the agricultural sector, particularly, the food sector. Capital[92] and labour demand in the food sector increased, on average, by 0.75% and 6.04% respectively (see Figure 6.1A and B). The demand for labour in the food sector was higher than the demand for capital because the Nigerian food sector is labour-intensive. Also, due to the higher price incentive, labour demand rose in the food sector but declined in the other sectors. However, capital demand in other sectors such as other crops, livestock, other agriculture, manufacturing and services increased by 0.2%, 0.17%, 0.18%, 0.09% and 0.24% respectively. The positive capital demand experienced by these sectors can be tied partly to their non-use of land, which is employed only in the food and other crops sectors.

These factor-demand effects triggered changes in factor returns (see Table L and M in Appendix E1). With increase in wages by 2.26% and the returns on capital in most sectors averaging between 5.66% (for the food sector) and 0.33% (for the transport sector), households' labour and capital income increased. Labour income increased by 2.1% across all household categories, while capital income rose by 3.53% and 0.12% for rural and urban households respectively (see Table 6.1 above). The higher capital income gain enjoyed by rural households supports their higher total income effects. This is attributable to the possession of farm-lands by rural households and suggestive of some level of increased utilization of that factor. Transfer income from government and the Rest of the World (ROW) which rose by 2.54% across all household categories also contributed to households' total income effect (see Table 6.1 above). This follows from the assumption that income from the various sources is distributed among households in fixed proportions.[93]

In comparison with the magnitude of the shock (37%), the less than 3% households' income effect across all households appears small. A number of factors including information asymmetry on the part of domestic food producers of the exact time of the price increase; constraints in the agricultural sector (particularly, the food sector) which limited the expansion of food production to only 3.73% in the first period, 4.10% in the fifth period and 3.93% on average over the simulation period; and, the activities of middle-men (who are often times not the food producers but have more

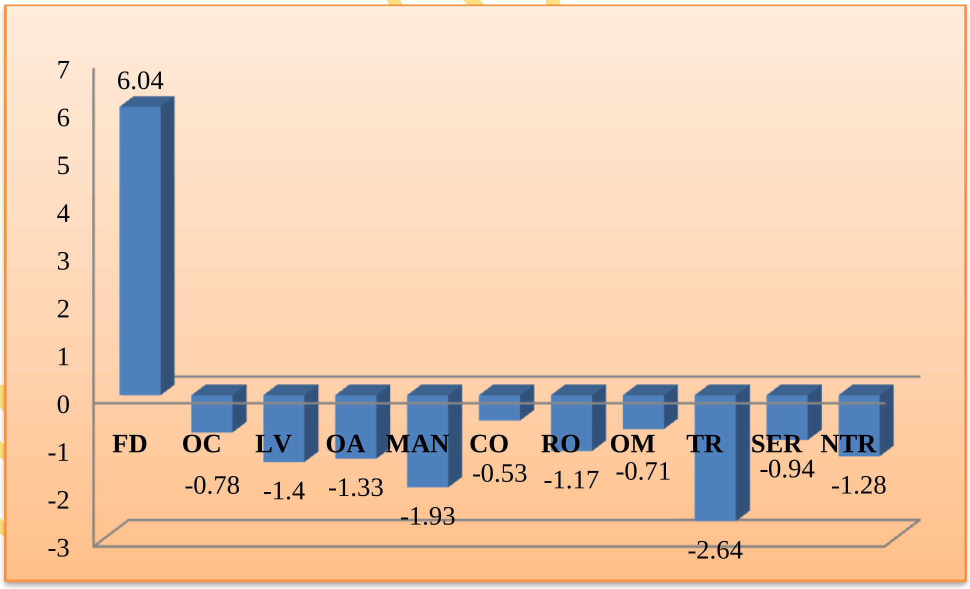
[92] This actually refers to composite capital – the combination of land and capital
[93] See Section 5.3.1b, in Chapter Five

information about the markets than the food producers) in the agricultural value-chain. Subsistence small scale holdings, low mechanization, high cost of farm inputs, and poor access to markets are some of the constraints that may have curbed the higher price incentive to expand domestic production of food. In addition, the possibilities of other supply-side factors such as disruption in rainfall coupled with lack of proper irrigation system may have narrowed domestic production expansion. As argued by the National Working Group on Agriculture and Food Security (2009), food production growth in Nigeria has been driven entirely by expansion in area planted (supporting our finding of increased demand for land) rather than intensification of area planted.



Source: Results from the CGE model
Note: FD=Food, OC=Other crops, LV=Livestock, OA=Other agriculture, MAN=Manufacturing, CO=Crude oil, RO= Refined oil, OM=Other mining, TR=Transport, SER=Service
Values represent percentage change from base year value.

Figure 6.1A. Industry demand for composite capital (KDC)



Source: Results from the CGE model
Note: FD=Food, OC=Other crops, LV=Livestock, OA=Other agriculture, MAN=Manufacturing, CO=Crude oil, RO= Refined oil, OM=Other mining, TR=Transport, SER=Service
Values represent percentage change from base year value.

Figure 6.1B. Industry demand for labour (LD)

(ii) Consumption Effects

Over the simulation period, across all commodities, a 37% increase in world food price decreased consumption by 1.43%, 0.82%, and 0.21% for rural poor, urban poor, and urban non-poor households respectively (Table 6.3). However, rural non-poor households' consumption increased by 0.61%. The higher income (2.9%) gained by the rural non-poor households compared to the other households categories may partly be responsible for this as it raised their consumption budget. In addition, the consumption share of various commodities in the consumption basket of the households and the effects the price shock on these commodities domestic prices partly explains the direction and magnitude of the observed impact.

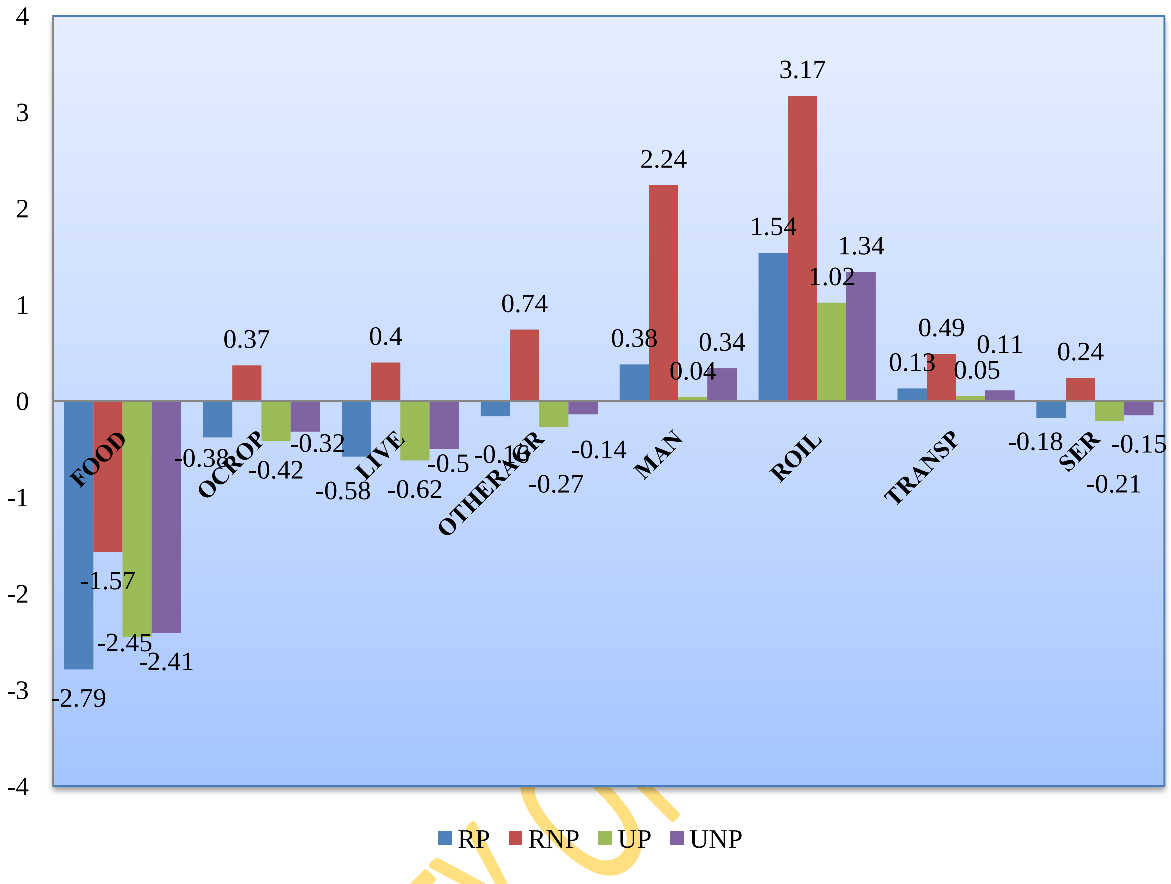
Figure 6.2 provides evidence on the effects of the shocks on households' consumption of commodities. The figure shows that for all household categories their food consumption declined. This is due from the higher price of food which reduced food imports significantly but expanded domestic production marginally, thus, leading to a decline in composite food commodity. The contraction in composite food commodity compared to the huge decline in food imports may be due to the fact that domestic production of food dominates food composite commodity in the Nigerian food sector. It is worth pointing out that, although Nigeria imports most of its rice and wheat needs, the other components of the food basket (maize, sorghum, millet and cassava) are largely produced in the country. Rural poor households had the highest food consumption decline, about 2.8%, while the rural non-poor households were the least affected, about 1.6%. The negative effect of the shock on the non-poor households was less than that of the poor households because the poor spend more on the consumption of food. Theoretically, it is expected that the positive income effects reaped by households due to the shock should stimulate consumption. However, the effect of the shock on the price of food composite (6.48%) as well as the local price of food (3.24%) was much higher than their consumption budget, thereby, forcing down consumption.

Consumption of other crops, livestock and other agriculture commodities also declined for all household categories except the rural non-poor households whose consumption increased by about 0.4% for other crops and livestock commodities, and 0.7% for other agricultural commodities. Besides these commodities, rural non-poor households benefited more, in terms of their consumption, than other households. This is expected given that the consumption budget of the rural non-poor household was much higher than the other households. As such, the effect of the food price shock on their consumption was less since they all faced the same purchaser price increase and fixed minimum consumption. Additionally, Figure 6.2 indicates that the other households' consumption of manufacturing, refined oil, transport and services commodities also increased. The decline in households' real consumption of most commodities (relative to the increase in consumption of some other commodities) suggests a negative aggregate welfare loss.

Table 6.3. Households' consumption effect of food price shock

T	RP	RNP	UP	UNP
1	-1.53	0.56	-0.86	-0.23
2	-1.47	0.59	-0.83	-0.21
3	-1.42	0.62	-0.81	-0.21
4	-1.38	0.64	-0.80	-0.20
5	-1.34	0.66	-0.78	-0.20
Av	***-1.43***	***0.61***	***-0.82***	***-0.21***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average



Source: Results from the CGE model
Note: FD=Food, OC=Other crops, LV=Livestock, OA=Other agriculture, MAN=Manufacturing, CO=Crude oil, RO= Refined oil, OM=Other mining, TR=Transport, SER=Service
Values represent percentage change from base year value.

Figure 6.2. Consumption of commodities by households

(iii) Aggregate Economic Effects

The consequence of the food price shock on aggregate macroeconomic activities is a summation of several microeconomic impacts. Thus, the underlying mechanism driving aggregate effects resulting from the shocks draws from the implications of the shock on different sectors in the economy.

On average, as depicted by Figure 6.3, a 37% increase in international price of food increased gross domestic product (GDP), total investment (IT) and aggregate household income (YH) by 1.24%, 1.83% and 2.05% respectively. Increase in domestic production resulting from the higher price incentive contributed to the rise in GDP. Also, the increased labour income due to higher wage-rate and fixed savings rate raised both aggregate household income and total investment respectively. With the exception of GPD, IT and YH, the shock led to a decline of other macro variables of interest. For instance, government income (YG) and government savings (SG) declined by 0.33% and 1.29% respectively. Aggregate export and import also declined by 0.21% and 0.33% respectively. Notwithstanding the fall in government savings, total investment is seen to increase by 1.83%. Since total investment is driven by savings from domestic and foreign agents. The positive effect of investment implies that increases in households and foreign savings outweighs the fall in government savings (see Table T in Appendix E1).

Source: Results from the CGE model
Note: Values represent percentage changes from base year value. GDP = Gross Domestic Product; YG = Government Revenue; SG = Government Savings; IT = Total Investment; EX = Aggregate Export; IM = Aggregate Import; YH = Aggregate Household Income.

Figure 6.3. Aggregate economic effects of food price shocks

6.2.2 Oil Shock Scenario

(i) Income Effects

The two simulations in the oil shock scenario reveal that a positive shock to the international price of refined oil decreased households income. In the first simulation which assumed a 60% increase in the international price of refined oil (S2OIL1), income correspondingly declined by 6.1%, 5.5%, 5.6% and 4.3% for rural poor, rural non-poor, urban poor and urban non-poor households. Even when the country experiences a similar shock-magnitude as that of food (S2OIL2), household incomes still declined by 3.9%, 3.5%, 3.6% and 2.8% for rural poor, rural non-poor, urban poor and urban non-poor households respectively (see Table 6.4). Weak domestic supply response may partly be responsible for the observed negative income effects through the reallocation of productive factors and their final effects on factor earnings.

With the increase in the price of refined oil, its domestic supply increased by 33.9% for S2OIL1 and 20.8% for S2OIL2 (Table 6.5A). These impacts are, however, marginal given that the share of domestic production of refined oil in composite refined oil is small (less than 20%). For instance, despite the increase in domestic supply of refined oil, total refined oil available in the domestic market declined by 7.8% and 5.6% (see Table V in Appendix E1) as imports of refined oil reduced by 24% and 16.4% for a corresponding 60% and 37% increase in the international price of refined oil (Table 6.5B).

It should be noted that government's subsidy on domestic consumption of refined oil, which is captured as a negative import-tax on refined oil, offsets the full effects of increases in the international price of refined oil. Nevertheless, given that the other sectors make use of refined oil in their production process, they are also affected by the price shock on the refined oil sector. For instance, given the transport sector's intermediate consumption of refined oil (45.5%, see Table 5.2b in Chapter Five) and changes in the domestic price of transport good (4.3% in S2OIL1 and 2.8% in S2OIL2, see Table F in Appendix E1), the domestic supply of transport sector declined by about 5.2% and 3.9% in S2OIL1 and S2OIL2 respectively. With the exception of livestock sector whose intermediate consumption of refined oil (0.01% of its total intermediate demand for refined oil) is negligible, other sectors' domestic supply also declined.

Table 6.4. Households' income effects for oil price shock

	Total income of type *h* households (YH)											
	H-R-P			H-R-NP			H-U-P			H-U-NP		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	2,641,967	-7.23	-4.48	3,647,130	-6.42	-3.97	2,631,358	-6.62	-4.11	6,532,744	-4.81	-2.98
2	2,721,226	-5.56	-3.68	3,756,544	-4.99	-3.3	2,710,299	-5.11	-3.38	6,728,727	-3.83	-2.54
3	2,802,863	-5.62	-3.66	3,869,240	-5.09	-3.31	2,791,608	-5.18	-3.37	6,930,589	-4	-2.6
4	2,886,949	-5.86	-3.77	3,985,317	-5.36	-3.45	2,875,356	-5.42	-3.48	7,138,506	-4.29	-2.76
5	2,973,557	-6.2	-3.96	4,104,877	-5.72	-3.65	2,961,617	-5.76	-3.67	7,352,661	-4.67	-2.98
Av	*2,805,312*	***-6.09***	***-3.91***	*3,872,622*	***-5.52***	***-3.54***	*2,794,048*	***-5.62***	***-3.6***	*6,936,645*	***-4.32***	***-2.77***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.5A. Total aggregate output (XST)

T	FOOD BAU N' Million	FOOD S2OIL1	FOOD S2OIL2	OCROP BAU N' Million	OCROP S2OIL1	OCROP S2OIL2	LIVE BAU N' Million	LIVE S2OIL1	LIVE S2OIL2	OTHERAGR BAU N' Million	OTHERAGR S2OIL1	OTHERAGR S2OIL2
1	2,821,815.80	1.15	0.71	3,323,270.57	0.66	0.40	440,653.47	-0.44	-0.25	420,401.17	2.22	1.36
2	2,906,470.28	0.48	0.32	3,422,968.69	0.06	0.05	453,873.08	-1.3.0	-0.83	433,013.20	1.14	0.78
3	2,993,664.39	0.19	0.11	3,525,657.75	-0.27	-0.19	467,489.27	-2.19	-1.41	446,003.60	0.79	0.51
4	3,083,474.32	-0.09	-0.08	3,631,427.49	-0.60	-0.42	481,513.95	-3.15	-2.04	459,383.70	0.48	0.29
5	3,175,978.55	-0.37	-0.28	3,740,370.31	-0.96	-0.65	495,959.37	-4.21	-2.72	473,165.22	0.17	0.08
Av	*2,996,280.67*	***0.27***	***0.16***	*3,528,738.96*	***-0.22***	***-0.16***	*467,897.83*	***-2.26***	***-1.45***	*446,393.38*	***0.96***	***0.6***

T	MAN BAU N' Million	MAN S2OIL1	MAN S2OIL2	COIL BAU N' Million	COIL S2OIL1	COIL S2OIL2	ROIL BAU N' Million	ROIL S2OIL1	ROIL S2OIL2	OMIN BAU N' Million	OMIN S2OIL1	OMIN S2OIL2
1	2,729,185.77	0.35	0.23	7,455,559.84	0.03	0.02	275,325.59	3.00	1.99	35,852.22	0.47	0.28
2	2,811,061.35	-0.69	-0.43	7,679,226.64	-1.33	-0.77	283,585.36	38.8	21.92	36,927.78	-1.03	-0.61
3	2,895,393.19	-1.52	-0.98	7,909,603.43	-2.21	-1.36	292,092.92	42.34	25.86	38,035.62	-1.98	-1.25
4	2,982,254.98	-2.40	-1.56	8,146,891.54	-3.17	-1.98	300,855.71	42.96	27.03	39,176.69	-2.97	-1.90
5	3,071,722.63	-3.35	-2.18	8,391,298.28	-4.27	-2.67	309,881.38	42.36	27.10	40,351.99	-4.07	-2.60
Av	*2,897,923.58*	***-1.52***	***-0.98***	*7,916,515.95*	***-2.19***	***-1.35***	*292,348.19*	***33.89***	***20.78***	*38,068.86*	***-1.92***	***-1.22***

T	TRANSP BAU N' Million	TRANSP S2OIL1	TRANSP S2OIL2	SER BAU N' Million	SER S2OIL1	SER S2OIL2	NTR BAU N' Million	NTR S2OIL1	NTR S2OIL2
1	822,836.49	-5.10	-3.18	6,111,682.71	-0.84	-0.51	3,108,960.07	-0.18	-0.11
2	847,521.58	-4.78	-3.12	6,295,033.19	-0.98	-0.64	3,202,228.87	-0.39	-0.22
3	872,947.23	-5.06	-3.30	6,483,884.18	-1.31	-0.85	3,298,295.74	-0.34	-0.2
4	899,135.65	-5.4o	-3.53	6,678,400.71	-1.68	-1.09	3,397,244.61	-0.24	-0.15
5	926,109.72	-5.76	-3.78	6,878,752.73	-2.09	-1.35	3,499,161.95	-0.10	-0.08
Av	*873,710.13*	***-5.22***	***-3.88***	*6,489,550.70*	***-1.38***	***-0.89***	*3,301,178.25*	***-0.25***	***-0.15***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.5B. Quantity of product imported (IM)

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	215,567.33	-11.74	-7.34	105,017.35	-12.47	-7.82	88.39	-14.37	-9.02	154,421.59	-9.42	-5.87
2	222,034.35	-8.69	-5.79	108,167.87	-9.18	-6.13	91.04	-11.49	-7.7	159,054.24	-7.09	-4.73
3	228,695.38	-8.5	-5.54	111,412.91	-8.94	-5.83	96.3	-12.08	-7.96	163,825.87	-7.09	-4.63
4	235,556.24	-8.58	-5.51	114,755.30	-8.98	-5.77	96.58	-13.06	-8.53	168,740.64	-7.31	-4.72
5	242,622.93	-8.8	-5.59	118,197.96	-9.18	-5.81	99.48	-14.31	-9.28	173,802.86	-7.67	-4.91
Av	*228,895.25*	***-9.26***	***-100***	*111,510.28*	***-9.75***	***-6.27***	*94.36*	***-13.06***	***-8.5***	*163,969.04*	***-7.72***	***-4.97***

	MAN			*COIL*			*ROIL*			*OMIN*		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	2,692,373.35	-10.41	-6.49	1,353.64	6.05	4	784,233.43	-13.71	-9.65	101,995.83	-0.01	0.03
2	2,773,144.55	-8.11	-5.43	1,394.25	98.92	51.34	807,760.43	-25.16	-16.53	105,055.71	5.61	3.1
3	2,856,338.88	-8.55	-5.61	1,436.08	113.13	63.29	831,993.25	-26.52	-18.01	108,207.38	5.8	3.49
4	2,942,029.05	-9.31	-6.04	1,479.16	119.3	68.49	856,953.04	-27.11	-18.66	111,453.60	5.48	3.4
5	3,030,289.92	-10.29	-6.62	1,504.63	122.45	71.07	882,661.64	-27.42	-19.01	114,797.21	4.9	3.1
Av	*2,858,835.15*	***-9.33***	***-6.04***	*1,433.55*	***91.97***	***51.64***	*832,720.36*	***-23.98***	***-16.37***	*108,301.95*	***4.36***	***2.62***

	TRANSP			*SER*		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	563,244.00	4.02	2.48	528,127.84	-8.15	-5.09
2	580,141.32	3.54	2.29	543,971.68	-6.06	-4.08
3	597,545.56	3.45	2.24	560,290.83	-6.3	-4.14
4	615,471.92	3.34	2.18	577,099.55	-6.79	-4.41
5	633,936.08	3.19	2.1	594,412.54	-7.46	-4.79
Av	*598,067.78*	***3.51***	***2.26***	*560,780.49*	***-6.95***	***-4.5***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

The decline in domestic supply of most sectoral output suggests a reallocation of productive factors to more rewarding competitive sectors due to a higher of factor return incentive in the sectors. Table 6.6A indicates that the demand for capital in the refined oil sector increased by 34.1% and 20.8% on average, following a 60% (S2OIL1) and 37% (S2OIL2) increase in the international price of oil, respectively, while it decreased in other sectors. In the first period, the demand for capital is zero given the assumption of capital immobility in the first period. Thus, in both simulations, the capital demand increased steadily after the first period up to the fourth period before declining. These effects are motivated by the returns on the use of capital by the sector. The return on capital was about 55%, on average over the simulation.

The refined oil sector benefits the most from labour reallocation due to the shock in both simulations. The sector's demand for labour remained above its base year value over the simulation period. In the first simulation (S2OIL1), labour demand increased by 28.6%, 48.5% and 46.4% in the first, third and fifth period respectively. In similar periods of the second simulation, it increased by 20.2%, 30.7% and 29.7%. On average, labour demand increased by 44.1% and 28.3% in S2OIL1 and S2OIL2 respectively despite the fact that a lower substitution between capital and labour is allowed for the refined oil sector compared to other sectors. In absolute terms, these average increases are marginal given the small labour absorption in refined oil sector which is less than 2% of total value added. Food, other crops and other agricultural sectors labour demand also increased by 2%, 1.5% and 2.7% respectively when there is a 60% increase in the international price of refined oil.

Based on these effects on the factor market, households' capital and labour incomes declined (Table 6.7). Capital income declined by 5.8% and 1.6% for rural and urban households respectively following a 60% increase in the international price of refined oil. The negative impact on was more for rural households than urban households because agricultural land, which is the primary source of capital income for rural households, is not employed in the production of refined oil. Also, labour income fell by 6.3% and 4.1% across all household categories in the 60% and 37% refined oil price shock scenarios respectively given the assumption of fixed savings and tax rates. In addition, total transfer income of all household categories declined by 2.8% and 1.8% following a 60% and 37% shock in the international price of refined oil, respectively.

Table 6.6A. Demand for capital

	FOOD		OCROP		LIVE		OTHERAGR		MAN		COIL	
T	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2
1	0	0	0	0	0	0	0	0	0	0	0	0
2	-1.35	-0.87	-1.37	-0.88	-2.08	-1.29	-1.88	-1.14	-2.01	-1.24	-1.42	-0.82
3	-2.33	-1.56	-2.36	-1.58	-3.51	-2.27	-3.13	-2	-3.37	-2.17	-2.28	-1.4
4	-3.37	-2.27	-3.41	-2.3	-5.03	-3.28	-4.45	-2.86	-4.8	-3.11	-3.23	-2.01
5	-4.5	-3.03	-4.55	-3.07	-6.67	-4.36	-5.86	-3.77	-6.35	-4.13	-4.33	-2.7
Av	***-2.31***	***-1.55***	***-2.34***	***-1.57***	***-3.46***	***-2.24***	***-3.06***	***-1.95***	***-3.31***	***-2.13***	***-2.25***	***-1.39***

	ROIL		OMIN		TRANSP		SER	
T	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2
1	0	0	0	0	0	0	0	0
2	41.09	22.97	-1.7	-1.02	-2.45	-1.58	-2.1	-1.3
3	43.47	26.52	-2.68	-1.69	-4.15	-2.75	-3.51	-2.27
4	43.54	27.43	-3.73	-2.37	-5.83	-3.88	-4.98	-3.25
5	42.64	27.32	-4.9	-3.11	-7.56	-5.03	-6.55	-4.28
Av	***34.15***	***20.85***	***-2.6***	***-1.64***	***-4***	***-2.65***	***-3.43***	***-2.22***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.6B. Demand for labour

	Industry *j* demand for labour (LDC)											
	FOOD		*OCROP*		*LIVE*		*OTHERAGR*		*MAN*		*COIL*	
T	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2
1	2.00	1.22	1.25	0.76	-0.58	-0.32	3.3	2.01	0.73	0.48	1.55	0.94
2	1.66	1.1	1.18	0.78	-1.02	-0.66	2.36	1.56	0.38	0.24	-0.01	0.08
3	1.85	1.21	1.42	0.93	-1.68	-1.09	2.43	1.55	0.02	0	-0.75	-0.43
4	2.10	1.36	1.69	1.11	-2.42	-1.56	2.56	1.61	-0.38	-0.25	-1.56	-0.95
5	2.40	1.55	2	1.32	-3.26	-2.08	2.74	1.71	-0.82	-0.54	-2.48	-1.54
Av	***2.00***	***1.29***	***1.51***	***0.98***	***-1.79***	***-1.14***	***2.68***	***1.69***	***-0.01***	***-0.01***	***-0.65***	***-0.38***
	ROIL		*OMIN*		*TRANSP*		*SER*		*NTR*			
T	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2		
1	28.64	20.24	0.87	0.53	-8.2	-5.14	-0.98	-0.59	-0.07	-0.05		
2	49.19	30.55	-0.54	-0.3	-6.09	-4.01	-0.74	-0.5	-0.37	-0.21		
3	48.54	30.73	-1.36	-0.85	-5.54	-3.6	-0.85	-0.56	-0.31	-0.19		
4	47.53	30.29	-2.23	-1.42	-5.06	-3.27	-1	-0.65	-0.2	-0.14		
5	46.37	29.67	-3.21	-2.04	-4.56	-2.95	-1.18	-0.76	-0.06	-0.06		
Av	***44.05***	***28.3***	***-1.29***	***-0.82***	***-5.89***	***-3.79***	***-0.95***	***-0.61***	***-0.2***	***-0.13***		

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.7. Households capital, labour and transfer income effects

	Capital income of type *h* households (YHK)											
	H-R-P			H-R-NP			H-U-P			H-U-NP		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	491,906	-6.36	-3.94	1,817,510	-6.36	-3.94	304,086	-0.59	-0.37	2,209,020	-0.59	-0.37
2	506,663	-5.13	-3.39	1,872,036	-5.13	-3.39	313,208	-1.03	-0.67	2,275,290	-1.03	-0.67
3	521,863	-5.37	-3.49	1,928,197	-5.37	-3.49	322,605	-1.52	-0.98	2,343,549	-1.52	-0.98
4	537,519	-5.77	-3.72	1,986,043	-5.77	-3.72	332,283	-2.05	-1.33	2,413,856	-2.05	-1.33
5	553,644	-6.28	-4.03	2,045,624	-6.28	-4.03	342,251	-2.66	-1.71	2,486,271	-2.66	-1.71
Av	*522,319*	***-5.78***	***-3.71***	*1,929,882*	***-5.78***	***-3.71***	*322,887*	***-1.57***	***-1.01***	*2,345,597*	***-1.57***	***-1.01***
	Labour income of type *h* households (YHL)											
	H-R-P			H-R-NP			H-U-P			H-U-NP		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	2,050,795	-7.60	-4.71	1,267,110	-7.6	-4.71	2,206,290	-7.6	-4.71	3,575,461	-7.6	-4.71
2	2,112,319	-5.81	-3.85	1,305,123	-5.81	-3.85	2,272,478	-5.81	-3.85	3,682,725	-5.81	-3.85
3	2,175,689	-5.83	-3.79	1,344,277	-5.83	-3.79	2,340,653	-5.83	-3.79	3,793,206	-5.83	-3.79
4	2,240,959	-6.04	-3.89	1,384,605	-6.04	-3.89	2,410,872	-6.04	-3.89	3,907,003	-6.04	-3.89
5	2,308,188	-6.36	-4.06	1,426,143	-6.36	-4.06	2,483,198	-6.36	-4.06	4,024,213	-6.36	-4.06
Av	*2,177,590*	***-6.33***	***-4.06***	*1,345,452*	***-6.33***	***-4.06***	*2,342,698*	***-6.33***	***-4.06***	*3,796,522*	***-6.33***	***-4.06***
	Transfer income of type *h* households (YHTR)											
	H-R-P			H-R-NP			H-U-P			H-U-NP		
T	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2	BAU N' Million	S2OIL1	S2OIL2
1	99,266.46	-3.93	-2.42	562,509.92	-3.93	-2.42	120,982.68	-3.93	-2.42	748,263.76	-3.93	-2.42
2	102,244.45	-2.69	-1.79	579,385.22	-2.69	-1.79	124,612.16	-2.69	-1.79	770,711.67	-2.69	-1.79
3	105,311.78	-2.54	-1.64	596,766.78	-2.54	-1.64	128,350.53	-2.54	-1.64	793,833.02	-2.54	-1.64
4	108,471.14	-2.50	-1.58	614,669.78	-2.50	-1.58	132,201.04	-2.50	-1.58	817,648.01	-2.50	-1.58
5	111,725.27	-2.50	-1.55	633,109.88	-2.50	-1.55	136,167.07	-2.50	-1.55	842,177.46	-2.50	-1.55
Av	*105,403.82*	***-2.83***	***-1.80***	*597,288.32*	***-2.83***	***-1.80***	*128,462.70*	***-2.83***	***-1.80***	*794,526.78*	***-2.83***	***-1.80***

Source: Results from the CGE model

Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

The finding that incomes of households in Nigeria decline when the country faces a positive shock to the international price of refined oil is not far from Ajakaiye and Fakiyesi (2009) which found an overall decrease in household income in Nigeria. Specifically, average household income fell by 5.07% under a 63.5% positive oil shock scenario. In the current study, households' income declined by 5.2% on average over simulation period when the country is exposed to a 60% increase in the international price of refined oil. McDonald and van Schoor (2005) had a more dissagregated labour category. Notwithstanding, they found that incomes of skilled and unskilled labour declined by 0.9% and 0.6% in South Africa. However, contrary to this study's finding, they observed that rural households had slightly smaller decline in incomes than their urban counterparts.

(ii) Consumption Effects

The simulation results show that a positive shock to the international price of refined oil has negative impacts on households purchasing power, and hence, their consumption. With a 60% shock to the international price of refined oil, consumption declined by 2.5%, 2.6%, 2.7% and 2% for rural poor, rural non-poor, urban poor and urban non-poor, respectively, over the simulation period (Table 6.8). Urban poor households' consumption was more affected than rural poor households despite the fact that rural poor households experienced more decline in their income. This could be as a result of the fact that urban poor households consume more petroleum products as well as other commodities that uses petroleum as a productive input.

The negative effects on consumption can be attributed principally to the decline in households' income which reduced their consumption budget (based on the assumption that households saving rates has been fixed in the model). In addition, the consumption budget fall was exacerbated by declines in transfer income from the government since the government had to spend more in terms of subsidizing the domestic consumption of refined oil. Lesser weight may be attached to the increase in the price of transportation resulting from the shock in the price of refined oil since the prices of other commodities consumed by households declined marginally. It is worth noting that the magnitude of the effect on households' consumption is small compared to the magnitude of the shock because of government's intervention in the commercial energy market by fixing the domestic price of refined oil. As such, economic agents are considerably insulated from the full impacts of the shock.

Table 6.8. Households' consumption effects for oil price shocks

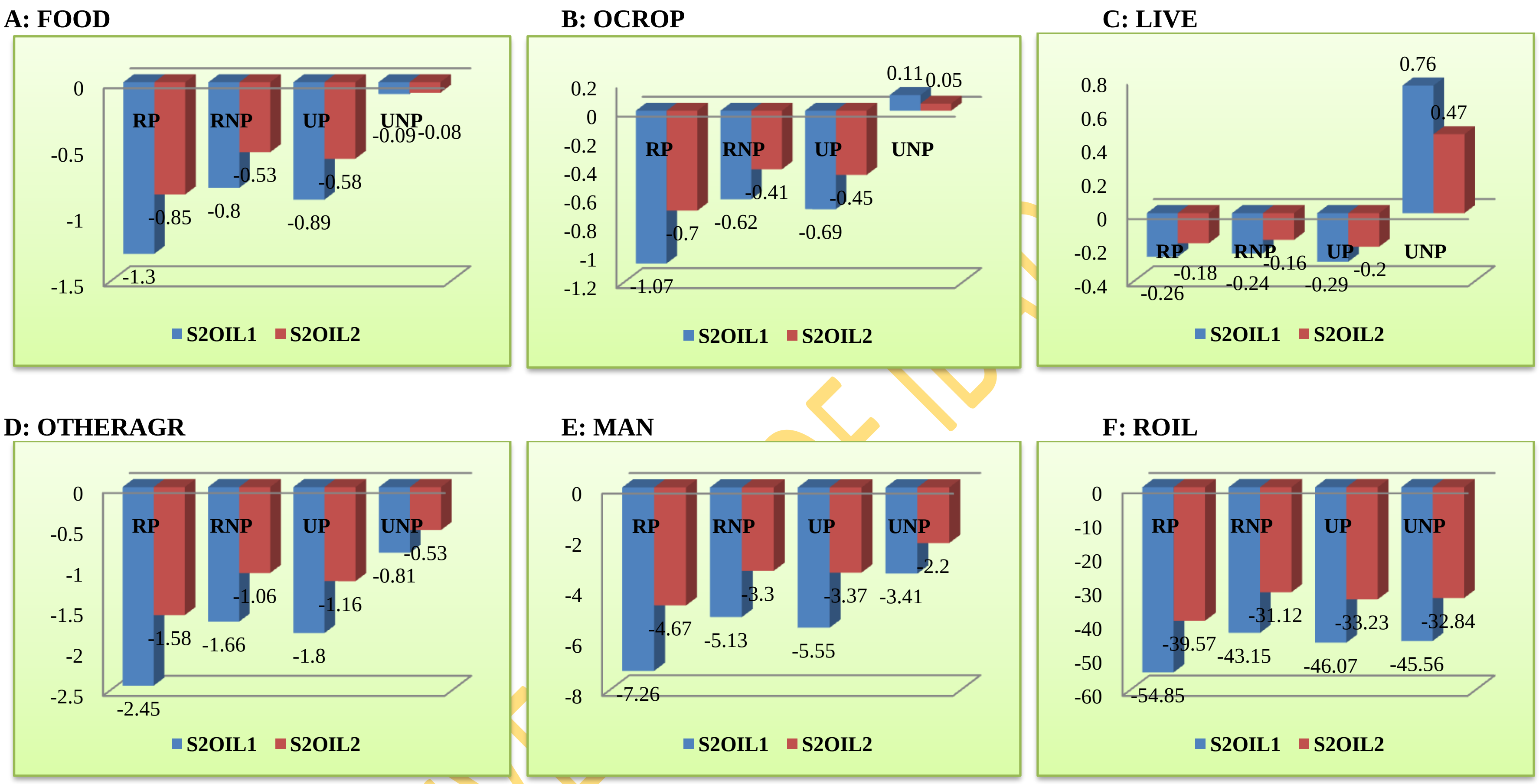
	RP		RNP		UP		UNP	
T	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2	S2OIL1	S2OIL2
1	-2.23	-1.41	-2.39	-1.51	-2.58	-1.65	-1.52	-1.04
2	-2.05	-1.37	-2.19	-1.46	-2.31	-1.56	-1.67	-1.14
3	-2.32	-1.54	-2.46	-1.63	-2.55	-1.7	-1.96	-1.33
4	-2.65	-1.75	-2.79	-1.84	-2.85	-1.88	-2.27	-1.53
5	-3.02	-1.99	-3.17	-2.08	-3.2	-2.1	-2.63	-1.76
Av	***-2.45***	***-1.62***	***-2.6***	***-1.71***	***-2.7***	***-1.78***	***-2.01***	***-1.36***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Considering the effects of the shocks (that is, both the 60% and 37% increase in the international price of refined oil) on the households' consumption of specific commodities, it can be seen that poor households experienced more negative consumption effect than non-poor households (Figure 6.4). Food consumption fell by 1.3%, 0.8%, 0.9% and 0.1% for rural poor, rural non-poor, urban poor and urban non-poor households, respectively. These were less than the negative effects on households' food consumption when they faced a 37% increase in the price of food. Thus, with a similar shock magnitude as that of food, the negative effects on households' food consumption are even far less. However, unlike the food shock scenario, urban non-poor households' consumption of other crops and livestock commodities increased; but their consumption of refined oil, manufacturing, transport, and services goods declined as with other household categories.

These findings are in consonance with Ajakaiye and Fakiyesi (2009). They also find oil price shock has negative impacts on household purchasing power and consumption, and that the poorest households are more affected. It is worth pointing out that their study considered negative shocks to the international price of crude oil as opposed to positive shocks to the international price of refined oil carried out in this study. However, since crude oil is the core intermediate input in the production of refined oil, an increase in the international price of crude oil would necessarily feed into the price of refined oil, thus making the scenario considered in the current study an approximation of the crude oil shock case-scenario.

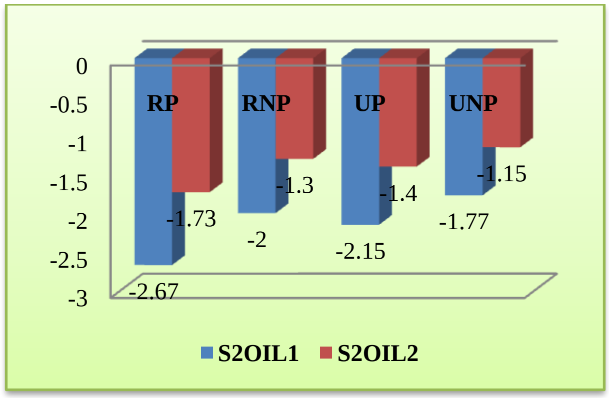
A noteworthy observation is that the households' income effects of a positive shock to the international price of food are positive while they are negative in the case of positive shocks to the international price to refined oil, even if they are of the same magnitude. The structure of the Nigerian economy in relation to its imports and domestic production in the two sectors provides a credible explanation for the observed effects. While the share of food imports in total food commodity available in the domestic market is less than domestic production, Nigeria imports over 70% of its refined petroleum products.



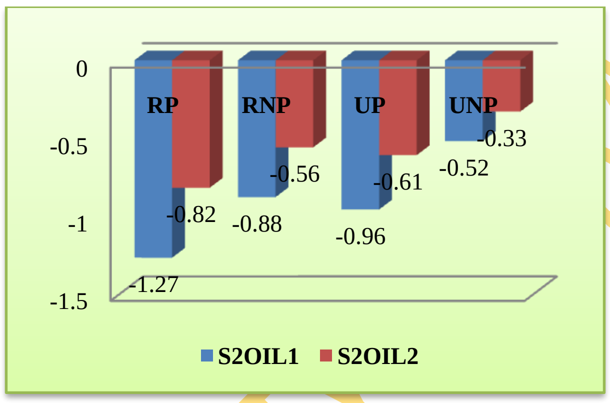
Source: Results from the CGE model
Note: Values represent percentage change from base year value.

Figure 6.4. Consumption of commodities by households for oil shock

G: TRANSP



H: SER



Source: Results from the CGE model

Note: Values represent percentage change from base year value.

Figure 6.4. Consumption of commodities by households *continued*

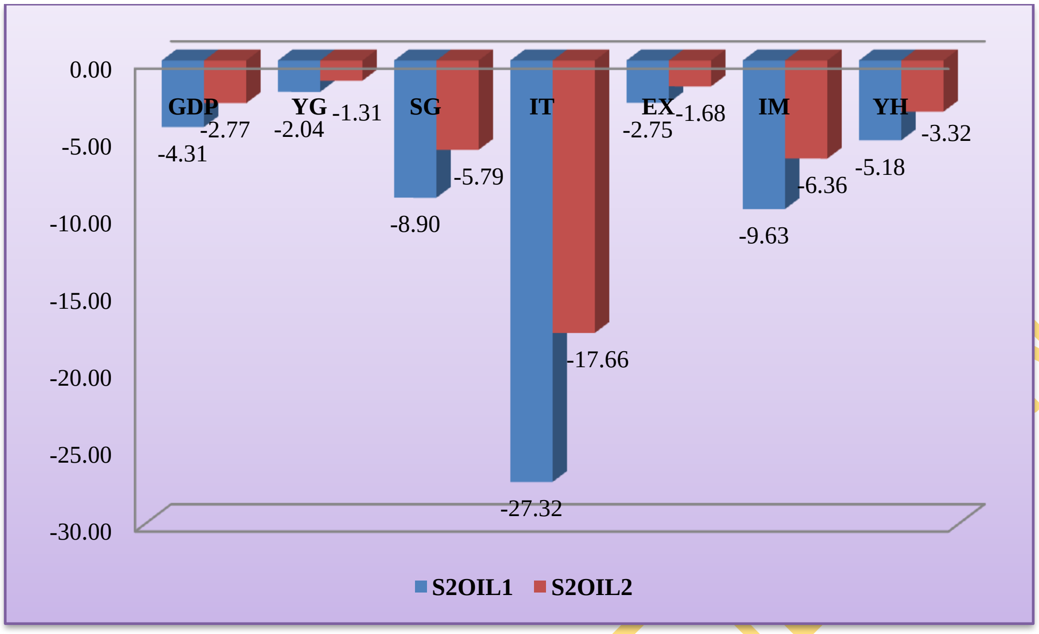
A possible implication is that with increases in the international price of food, imports can be substituted for domestic production or other food crops. This leads to expansion of the food sector not only in terms of production but also in value added and the returns thereof. This translates to increased income for households. However, since domestic refined petroleum needs is met mainly by imports, and government's intervenes in the pricing of petroleum through subsidy, increases in the international price of refined oil may expand domestic production, decrease imports but may not improve households' income for two reasons. One is because, the share of wages in the refined oil sector out of the total wage bill is very small (about 0.01%); and two, although a very capital intensive sector, the share of profits made by the sector is also very small. In fact, as noted by Odularo (2008), not all of the industry's value added is retained in the country because of the massive involvement of foreign operators in Nigeria's oil industry. Essentially, a substantial proportion is sent out in the form of factor payments profits, dividends, interest, fees, and wages and salaries paid abroad.

(iii) Aggregate Economic Effects

Positive shocks to the international price of refined oil generate severe impacts on the macro economy. Unlike the food price shock scenario, besides other variables which declined, GDP, total investment, and aggregate household income, fell by 4.31%, 27.32%, and 5.18% respectively following a 60% increase (S2OIL1) in the international price of refined oil (Figure 6.5). It is observed that even when the country faces a similar shock magnitude like the food scenario (37% - S2OIL2), macroeconomic variables are still negatively affected but with lesser impact when compared with S2OIL1. It is possible that the bias of the economy towards the oil sector is responsible for the impact-variance between food and oil price shock. While crude oil export dominates Nigeria's export, and the country imports most of its refined petroleum needs; food constitutes a small part of total imports in country. In addition, government revenue is observed to depend majorly on taxes on crude oil exploration as well as receipts from oil exports; hence, its susceptibility to vagaries in international price of oil.

While McDonald and van Schoor (2005), Essama-Nssah *et al.*, (2007), and Fofana *et al.*, (2007) found that an increase in the international price of oil leads to a reduction in GDP in South Africa, Ajakaiye and Fakiyesi (2009) found that negative oil price shocks have negative effects on GDP in Nigeria. This is, however, not surprising given that the South African country-studies considered the impacts of shocks to the international price of crude oil imports while Ajakaiye and Fakiyesi (2009) studied the impacts of shocks to the international price of crude oil exports. The reason for the direction of these studies may have stemmed from the fact that South Africa imports more of its crude oil needs which it then refines locally while Nigeria exports most of its crude oil. This study, however, considered the effects of shocks to the international price of refined petroleum. This partly explains the difference GDP impact obtained in this study from other studies.

Of all the macro variables, total investment experienced the highest negative decline in the event of a rise in the international price of refined oil. The huge negative decline in total investment can be attributed to the significant fall in government and household savings. With a fixed savings rate, a decline in income generated a reduction in savings, and hence, investment.



Source: Results from the CGE model
Note 1: Values represent percentage changes from base year value. GDP = Gross Domestic Product; YG = Government Revenue; SG = Government Savings; IT = Total Investment; EX = Aggregate Export; IM = Aggregate Import; YH = Aggregate Household Income.
Note 2: Values represent percentage change from base year value.

Figure 6.5. Aggregate economic effects of oil price shocks

6.3 Combined food and oil price shocks

This section presents the results of the effects of a scenario in which food and oil price shocks occur simultaneously. The goal of this section is to provide some knowledge on the household effects of a combined food and oil price shock in comparison with a single shock scenario as discussed in the preceding section as well as some underlying economic intuition driving the results.

The combined food and oil shock (that is, a 37% and 60% increase in the international price of food and oil, respectively) had negative impacts on the households' total income. Aggregate household income declined by 3% over the simulation period. Across all household categories, the initial impact of the shock was -4.8%, -3.6%, -4.6%, and -3.3% for the rural poor, rural non-poor, urban poor and urban non-poor households, respectively (Table 6.9). These negative impacts declined in the second period but increased thereafter over the remainder of the simulation period. This was because the larger negative income effects resulting from the oil price shock started increasing after the second period, thus, outweighing the smaller positive income effects from the food price shock which started falling from the second period. On average, household income fell by 3.7%, 2.7%, 3.7% and 2.8% for rural poor, rural non-poor, urban poor and urban non-poor households, respectively. In comparison with the oil shock scenario that assumed a 60% increase in the international price of refined oil, the negative impacts were less because of the positive income gains was reaped from the increase in world food price.

The households' income effects described above was driven by changes in capital income, labour income and transfer incomes from government and ROW. This suggests that either one of the sources of households' total income declined significantly that it overwhelmed any positive effects from other income sources or that all three sources of income were negatively affected by the shock. The latter case is true as revealed by the simulation results capture in Table 6.9. Capital income of rural households fell by 2.4% while it fell by 1.4% for urban households. This is plausible given that, besides land which represents a major part of rural households' capital income, their share of capital is small compared to government and ROW who own large part of capital employed in the refined oil sector - the only sector which experienced increase in its demand of capital. Demand for capital declined by 2.2%, on average, in the food sector (Figure 6.6) unlike the scenario that assumed only a 37% increase in the international price of food where capital demand increased by 0.8%. This indicates that the effects of the shock to international price of refined oil overwhelmed the sectors demand for capital. Other sectors also recorded declines in their capital demand. For instance, the demand for capital in the manufacturing, transport, and services sector fell by 3.8%, 4.8%, and 3.8%, on average, respectively (see Figure 6.6). This is due to the upward surge in the refined oil sector's demand for capital (about 40%) attributable to the high returns to capital in the sector. From the simulation results, the returns on capital in the refined oil sector increased by 53.8%, on average. It also increased after the first period of the shock in the food and crude oil sector, averaging about 2% and 1.4% over the simulation period (Table 6.10A).

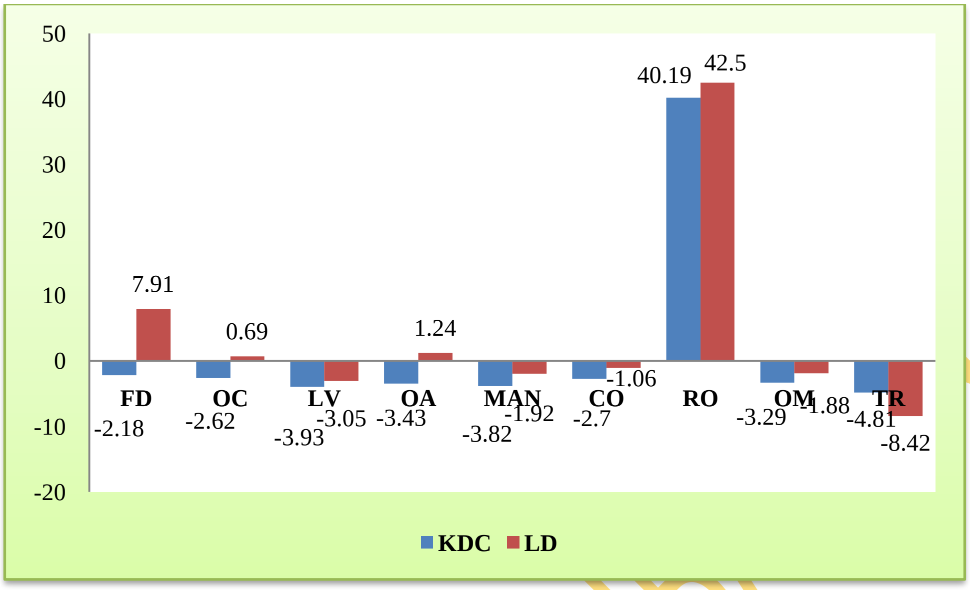
Figure 6.6 further shows that labour demand increased in the food, other crop, other agriculture, and refined oil sectors, as it declined in the other sectors. The refined oil sector enjoyed the largest gain from labour mobility (about 42.5%), followed by the food sector (about 7.9%). This is because they are the primary sectors via which the shock permeated into the economy. Given that the oil sector is less labour intensive, the increase in labour demand still represents a very small portion of the total labour supply compared to the labour absorbed by the food sector which represent a larger quantum of total labour supply given the labour-intensive nature of the sector. However, labour income declined by 4.18% across all household categories due to the fall in wage rate by about 4.23%.

Fundamentally, it was changes in the product market (demand for and supply of composite commodities) arising from the higher international price of food and oil that created the ripple effects in the factor market. For instance, the simulation results shows a lowering of total food available in the domestic market by 3.1% due to a higher decline in food imports (42.2%, on average) and a lower rise in domestic food production (4%, on average). Also, domestic production of other commodities declined (between 0.6% for other crops and 8.2% for transport). Given the inter linkages of the different sectors of the economy, the overall effects of the shock on the different sectors can be attributed to the magnitude of their interdependence in terms of intermediate demand as well as the perturbation caused by the shock.

Table 6.9. Household income effects for combined food and oil price shock

	Total income of type *h* households (YH)							
	H-R-P		H-R-NP		H-U-P		H-U-NP	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	2,641,967	-4.82	3,647,130	-3.60	2,631,358	-4.65	6,532,744	-3.27
2	2,721,226	-3.16	3,756,544	-2.15	2,710,299	-3.16	6,728,727	-2.30
3	2,802,863	-3.24	3,869,240	-2.27	2,791,608	-3.25	6,930,589	-2.47
4	2,886,949	-3.48	3,985,317	-2.54	2,875,356	-3.50	7,138,506	-2.77
5	2,973,557	-3.83	4,104,877	-2.90	2,961,617	-3.84	7,352,661	-3.15
Av	2,805,313	***-3.70***	3,872,621	***-2.69***	2,794,048	***-3.68***	6,936,646	***-2.79***
	Capital income of type *h* households (YHK)							
	H-R-P		H-R-NP		H-U-P		H-U-NP	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	491,906	-3.02	1,817,510	-3.02	304,086	-0.43	2,209,020	-0.43
2	506,663	-1.74	1,872,036	-1.74	313,208	-0.85	2,275,290	-0.85
3	521,863	-1.96	1,928,197	-1.96	322,605	-1.32	2,343,549	-1.32
4	537,519	-2.35	1,986,043	-2.35	332,283	-1.83	2,413,856	-1.83
5	553,644	-2.84	2,045,624	-2.84	342,251	-2.42	2,486,271	-2.42
Av	522,319	***-2.38***	1,929,882	***-2.38***	322,887	***-1.37***	2,345,597	***-1.37***
	Labour income of type *h* households (YHL)							
	H-R-P		H-R-NP		H-U-P		H-U-NP	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	2,050,795	-5.42	1,267,110	-5.42	2,206,290	-5.42	3,575,461	-5.42
2	2,112,319	-3.65	1,305,123	-3.65	2,272,478	-3.65	3,682,725	-3.65
3	2,175,689	-3.70	1,344,277	-3.70	2,340,653	-3.70	3,793,206	-3.70
4	2,240,959	-3.92	1,384,605	-3.92	2,410,872	-3.92	3,907,003	-3.92
5	2,308,188	-4.24	1,426,143	-4.24	2,483,198	-4.24	4,024,213	-4.24
Av	2,177,590	***-4.18***	1,345,451	***-4.18***	2,342,698	***-4.18***	3,796,521	***-4.18***
	Transfer income of type *h* households (YHTR)							
	H-R-P		H-R-NP		H-U-P		H-U-NP	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	99,266.46	-1.37	562,509.92	-1.37	120,982.68	-1.37	748,263.76	-1.37
2	102,244.45	-0.13	579,385.22	-0.13	124,612.16	-0.13	770,711.67	-0.13
3	105,311.78	-0.03	596,766.78	-0.03	128,350.53	-0.03	793,833.02	-0.03
4	108,471.14	-0.02	614,669.78	-0.02	132,201.04	-0.02	817,648.01	-0.02
5	111,725.27	-0.06	633,109.88	-0.06	136,167.07	-0.06	842,177.46	-0.06
Av	105,403.82	***-0.32***	597,288.32	***-0.32***	128,462.70	***-0.32***	794,526.79	***-0.32***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average



Source: Results from the CGE model
Note: FD = FOOD; OC = OCROP; LV = LIVE; OA = OTHERAGR; CO = COIL; OM = OMIN; TR = TRANSP. Other variables are as defined in the source Tables. Values represent percentage deviations from base year values.

Figure 6.6. Demand for composite capital (KDC) and labour (LD)

Table 6.10A. Rental rate of industry *j* composite capital (RC)

	FOOD	*OCROP*	*LIVE*	*OTHERAGR*	*MAN*	*COIL*	*ROIL*	*OMIN*	*TRANSP*	*SER*	*NTR*
T	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM	S3SIM
1	-0.77	-5.40	-6.91	-4.54	-6.48	-0.58	219.43	-4.35	-12.51	-6.86	-6.65
2	2.02	-2.51	-3.85	-1.86	-3.38	1.08	23.97	-0.66	-7.74	-3.39	-4.73
3	2.47	-1.90	-3.50	-1.16	-2.85	1.64	11.79	0.17	-6.42	-2.73	-4.79
4	2.87	-1.35	-3.28	-0.52	-2.43	2.20	7.59	0.91	-5.26	-2.18	-4.96
5	3.28	-0.81	-3.11	0.15	-2.04	2.84	6.35	1.68	-4.14	-1.66	-5.21
Av	***1.97***	***-2.39***	***-4.13***	***-1.59***	***-3.44***	***1.44***	***53.83***	***-0.45***	***-7.21***	***-3.36***	***-5.27***

Table 6.10B. Wage rate (W)*

T	S3SIM
1	-5.69
2	-3.57
3	-3.68
4	-3.93
5	-4.27
Av	***-4.23***

Source: Results from the CGE model
Note 1: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average
Note 2: Values in parenthesis represent base year rental rate of industry composite capital, and it is constant over the simulation period
*Wage rate was exogenously fixed at 1

On the consumption side, the simulation results (Table 6.11) showed that households' consumption declined correspondingly by 3.8%, 2.0%, 3.4% and 2.2% for rural poor, rural non-poor, urban poor and urban non-poor households. These negative effects are higher than those experienced by all household categories in the 37% food shock scenario as well as for rural and urban poor households in the 60% oil shock scenario. A number of reasons are responsible for the observed negative consumption effect from the combined oil shock scenario. First, is the decline in households' income which, to a large extent, determines household purchasing capacity. With a fixed rate of savings, decline in income reduces the consumption budget, and hence, consumption. Although, the fall in households income in the combined shock scenario were less than those observed in the first oil shock scenario, rural and urban poor households consumption fell more because of the other factor (price) which also partly explains the observed consumption effects. Since all household categories faced similar prices (since we have not assumed a heterogeneous market in the model), a higher negative income effects with rising prices reduced the consumption space of poor households.

Figure 6.7 indicates that with the exception of non-poor households' consumption of livestock, consumption of commodities declined for all household categories. Besides consumption of refined oil which declined by over 40%, on average, across household categories; consumption of manufactured goods correspondingly declined by 6.7%, 2.9%, 5.4% and 3.0% for rural poor, rural non-poor, urban poor and urban non-poor households. This is expected since manufactured goods constitute a sizeable portion of households' consumption. For instance, non-poor rural households consume about 31.7% of manufactured goods – the highest in their consumption basket. Urban poor and non-poor households also consume about 26.8% and 29% of manufactured goods.

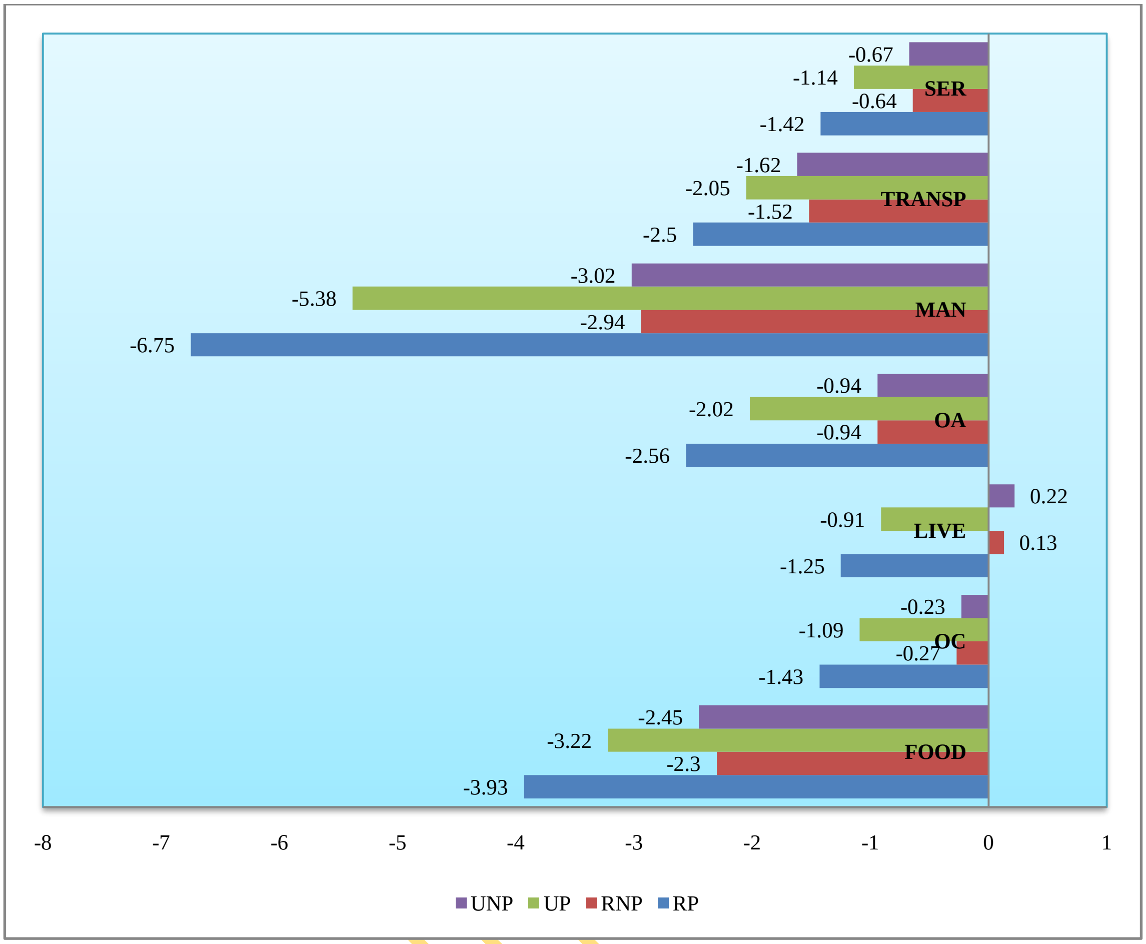
Food consumption declined by 3.9%, 2.3%, 3.2% and 2.5% for rural poor, rural non-poor, urban poor and urban non-poor households respectively. The fall in poor rural households' consumption was more than what obtained in the food shock and oil shock scenario, while the non-poor rural household were the least affected. The combined food and oil price shock imposed greater negative effects on food imports which clamped food composites despite the increase in domestic production.

These consumption declines are evident amidst decreases in domestic prices of these commodities (see Table E in Appendix E2) suggesting that the negative income is much higher than the price effects. Here again the role of changes in relative prices of imports and local product cannot be ignored. For instance, rising import prices of food and declining domestic prices shifts demand to local products. Notice that in this case, the domestic price of food declines from its base year values unlike in the food shock scenario where they increased. This major change can be attributed to the role of oil price shock in the perturbation process, which (without accounting for food price shock) generates negative effects on domestic food price.

Table 6.11. Consumption effects for a combined food and oil price shock

T	RP	RNP	UP	UNP
1	-3.62	-1.86	-3.36	-1.77
2	-3.43	-1.63	-3.08	-1.89
3	-3.65	-1.87	-3.30	-2.15
4	-3.93	-2.16	-3.56	-2.44
5	-4.26	-2.51	-3.87	-2.78
Av	***-3.78***	***-2.00***	***-3.44***	***-2.21***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average



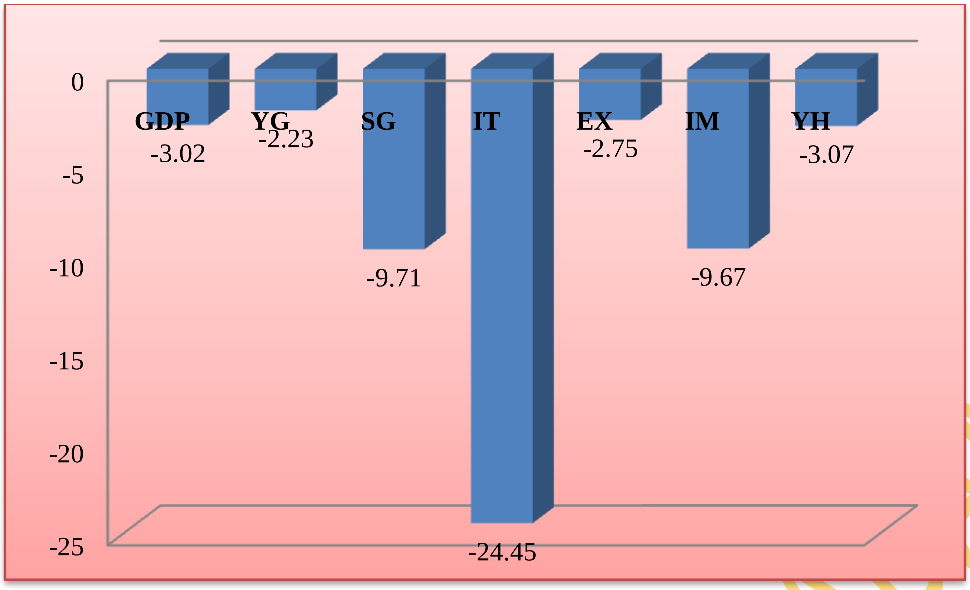
Source: Appendix E2 Table C; Based on simulation results from the CGE model
Note: OC = OCROP; OA = OTHERAGR. Other variables are as defined in the source Tables. Values represent percentage deviations from base year values. For clarity of the figures as shown above, households' consumption of refined oil has been excluded because its effects are large (over 40%).

Figure 6.7. Consumption of commodities by household for combined food and oil shock

From Figure 6.8, the combine shock simulations show that all aggregate economic variables of interest declined with total investment having the highest negative impact (-24.5%), followed by aggregate import (-9.7%). The least affected was government revenue which declined by 2.2%, representing a higher negative impact compared with the individual shock experiments. This is because government revenue declined in both scenarios - where international price of food and oil increased by 37% and 60% respectively.[94] The story is quite different for total investment and aggregate household income which both declined from their base year values by about 24.5% and 3.1% respectively. These negative effects are lower when compared with the scenario where oil price increased by 60% due, partly, to some positive impacts exacted by food price increase on these variables. However, unlike in the food shock scenario where GDP grew by 1.2% on average, in this combined scenario, it falls by 3.0%. This fall is lower than the decline in GDP when the country experienced a 60% increase in the international price of refined oil, but higher when a 37% increase world oil price was assumed.

From the discussions it is clear that in the combined shock scenario, the shocks either reinforces or offset each other partially. For instance, the positive macro effects (on GDP, total investment, and aggregate household income) that would have been reaped from increase in the international price of food is offset by the negative impact exacted on these variables when the country also faces a positive shock to the international price of refined oil.

[94] Please, see to Figure 17 and 19



Source: Results from the CGE model
Note: Values represent percentage changes from base year value. GDP = Gross Domestic Product; YG = Government Revenue; SG = Government Savings; IT = Total Investment; EX = Aggregate Export; IM = Aggregate Import; YH = Aggregate Household Income.

Figure 6.8. Aggregate economic effects of combined food and oil price shock

6.4 Transmission Mechanism

In this section, the channels via which the shocks are transmitted to households are identified and discussed. For ease of appreciation, a schema is presented at the end of the discussion with focus on key variables, activities, and agents in the transmission process.

6.4.1 Food Price Shock

A positive shock to the international price of food (PWM_f) by 37% increased the price of food import (PM_f) by the same magnitude.[95] This led to a fall in food imports by 40.9% which is more than the magnitude of the rise in food import price. The fall in import demand derives from simple demand theory – that an increase in price leads to a fall in quantity demanded. The magnitude of the fall in import demand is attributable to the fact that import depends not only on import price (PM) but also on share parameter of composite commodity (β_m^M), price of local product sold in the domestic market (PD), domestic demand for commodity produced locally (DD), and the elasticity of substitution between domestic production and imported goods. Thus, food imports fell because the rise in import price of food was higher than the domestic market price (3.2%), and hence, domestic demand (3.9%). The role of the elasticity of substitution between imports and domestic goods is also important. A relatively high elasticity means imports can easily be substituted for domestic production. It should be noted also that the imports of commodities also declined.

The decrease in food imports (-40.9%) and an increase in food's import price (37%), pushed up the purchaser's price of food composite commodity, PC, (6.5%). This led to a fall in the quantity demand of food composite commodity, Q_f, (-2.3%). Total available commodities in the economy is made up of imports and domestic production which is either consumed by households ($C_{i,h}$) or government (CG_i), or used as investment goods (INV_i). Quantity demand of food composite commodity declined much less than the fall in import not only because the share in food imports is small (about 0.34) but because domestic supply which constitute a larger portion of food composites increased by 3.9%.

[95] This is because it has been assumed in the model that all tax rates are fixed in the model (see Section 5.3.2 in Chapter Five)

With increased domestic supply (*DS*) of food, aggregate output (*XST*) of food increased. Since aggregate output is shared between sales in the domestic market and export, export declined due to lowered export price (PE_x) compared to price of local product (PL_i), and because the current account balance (*CAB*) was fixed. But aggregate output of food (as well as other commodities) is derived from the combination of total intermediate demand for commodity, *DIT*, and value added (*VA*). Value added of the food sector increased by 3.9% given increased labour demand (LD_f) by 6.0% and demand for composite capital (KDC_f) by 0.75%. Labour and capital demand in the food sector increased despite increase in wage rate (*W*) and return to capital (*RC*) because the other sectors frees up these factors which are then absorbed by the food sector.

An increase in the wage rate by 2.54% (which is constant across sectors) increased households' labour income (*YHL*) by 2.10% since each household received a fixed share of labour income. Households' capital income (*YHK*) also increased since return to composite capital increased. But, the share of capital income received by rural households (3.53%) was higher than what was received by urban households (0.12%). This is because land which is used in food production is owned by rural households.

In the Nigerian economy, labour constitutes the largest income source of Nigerian households; thus, changes in wage rate determine a large part of households' total income (*YH*). Transfer income (*YHTR*) contributes only a meagre part of households' total income. Thus, changes in factor demand (labour and land, in particular), and hence, factor returns represents the major channels via which positive shocks to the international price of food impact households income. This suggests that any policy on land use for agriculture, such as land tenure system, can affect productivity and hence, the income of households. In addition, as noted in the background story, much of food production in Nigeria has been driven by expansion in area planted rather than increase in productivity. The foregoing discussion clearly reveals that, had the country been food-sufficient, with strong food export potentials, households income gains would increase.

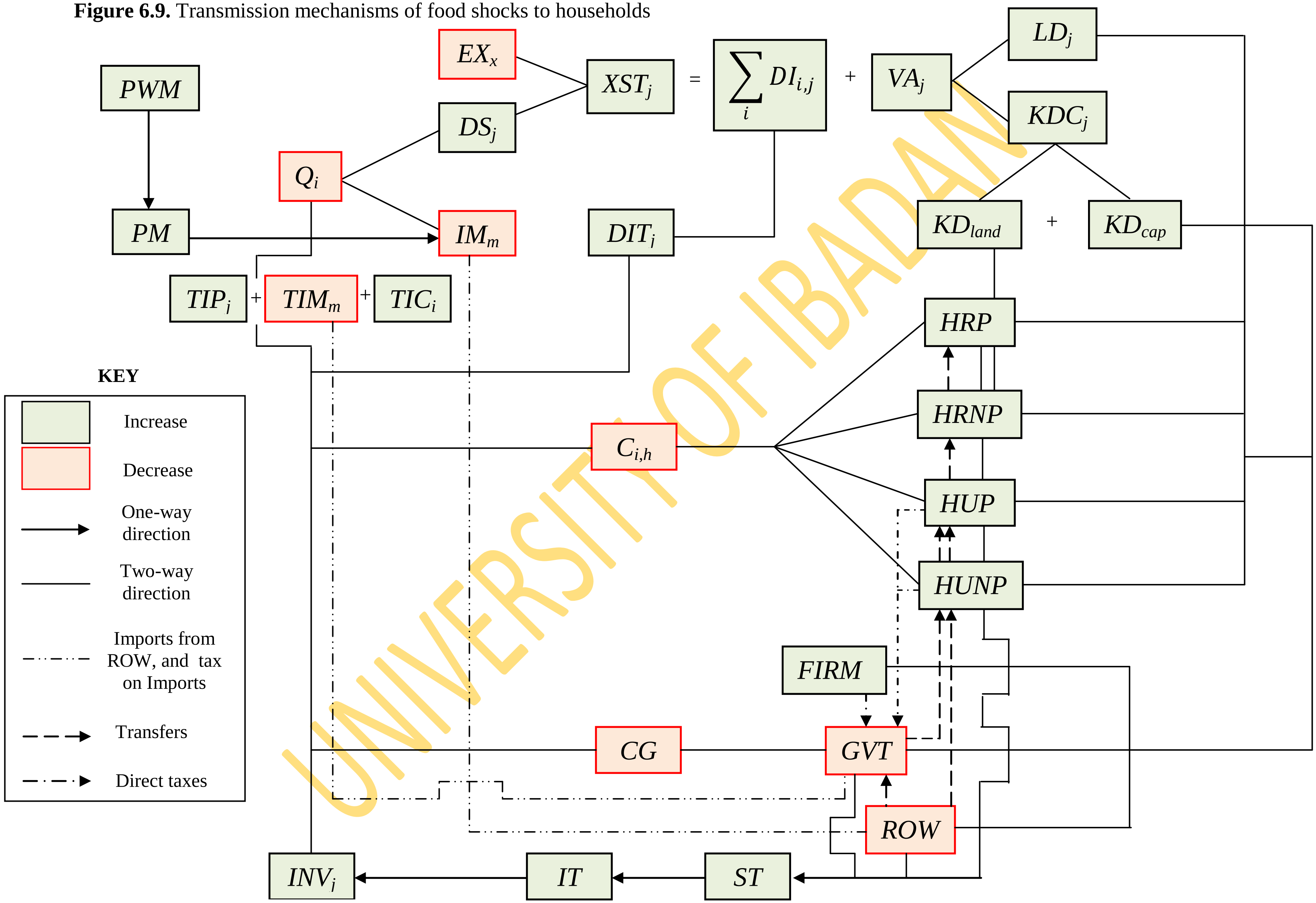
The increase in households' total income increased their disposable income (*YDH*). Consumption budget of households (*CTH*) also increased because the saving rate was fixed in the model. However, despite increases in the consumption budget of households, their real consumption of some commodities such as agricultural sectors products and services goods fall. A plausible explanation for the fall in the consumption of these commodities is their price. Increase in price of composite commodity (see Table E in Appendix E1) pushed household consumption down despite increase in consumption budget because household minimum consumption is assumed to be fixed in the model.

From the government side, the fall in aggregate import by 0.33% due to increase in the international price of food reduced the revenue generated from tax on import (*TIM*) of food, and subsequently, the total import tax revenue (*TIMT*) by 13.71% and total government revenue from taxes on products and imports (*TPRCTS*). Ultimately, government revenue (*YG*) declined by 0.32%. Government's income declined less than the fall in *TIMT* because other sources of government revenue such as total government receipts from indirect taxes, industrial production, transfer income, and taxes on households and firm increased, thereby, offsetting the maximum impact of the fall in *TIMT*. The fall in government revenue reduced its savings (*SG*) by 1.29% because its expenditure has been held fixed while transfer income to households increased.

The increase in household savings, however, offsets the fall in both government and ROW savings. ROW savings (*SROW*) declined because the positive shock to the international price of food reduced import for food, thus lowering their income and savings. This explains the increase in total investment (*IT*), and hence, investment-demand (*INV*). However, quantity of composite commodity available in the economy declined because of the fall in both households and government consumption outweighed the increase in *INV*.

The foregoing discussion is schematically represented by Figure 6.9 below.

Figure 6.9. Transmission mechanisms of food shocks to households



Source: Author's Initiative based on the Model and Simulation results

6.4.2 Oil Price Shock

Just as the case of food, an increase in the international price of refined oil (PWM_{roil}) by 60% increased the price of refined oil import (PM_{roil}) by the same magnitude. However, unlike the case of food, refined oil imports fell by 23.98% which is less than the magnitude of the rise in oil import price. The import-demand effect depends not only on import price (PM) but also on other prices variables, share parameter, and the elasticity of substitution. The lowered import-demand effect relative to the shock can be attributed to government's intervention in the market by regulating prices of petroleum. A second plausible justification is the fact that most of the country's refined oil need is met by imports.

The decrease in refined oil imports (-23.98%) reduced refined oil composite commodity, Q_{roil}, (-7.82%). This is because increase in domestic supply (*DS*) of refined oil partially offsets some of the short-fall in imports. With increase in domestic supply, aggregate output (*XST*) also increased. The increase in total output is derived from the combination of intermediate demand for commodity (*DIT*) and value added (*VA*). Value added of the refined oil sector increased by 33.89% given increases in labour demand (LD_{roil}) by 44.05% despite decrease in wage rate (*W*), and demand for composite capital (KDC_{roil}) by 34.15%.

A fall in the wage rate by 6.39% (which is constant across sectors) decreased households' labour income (*YHL*) by 6.33% since each household received a fixed share of labour income. Households' capital income (*YHK*) also declined despite increase in the return to composite capital in the extractive sectors because most of the sectors' capital is received by ROW. Government and ROW income transfers to households also declined. Given that labour constitutes the largest income source of Nigerian households, and its share in total valued added in the refined oil sector is very marginal, households' total income (*YH*) was adversely affected. With decreases in households' total income, their disposable income (*YDH*), and consumption budget (*CTH*) also decreased. Consequently, households' consumption declined.

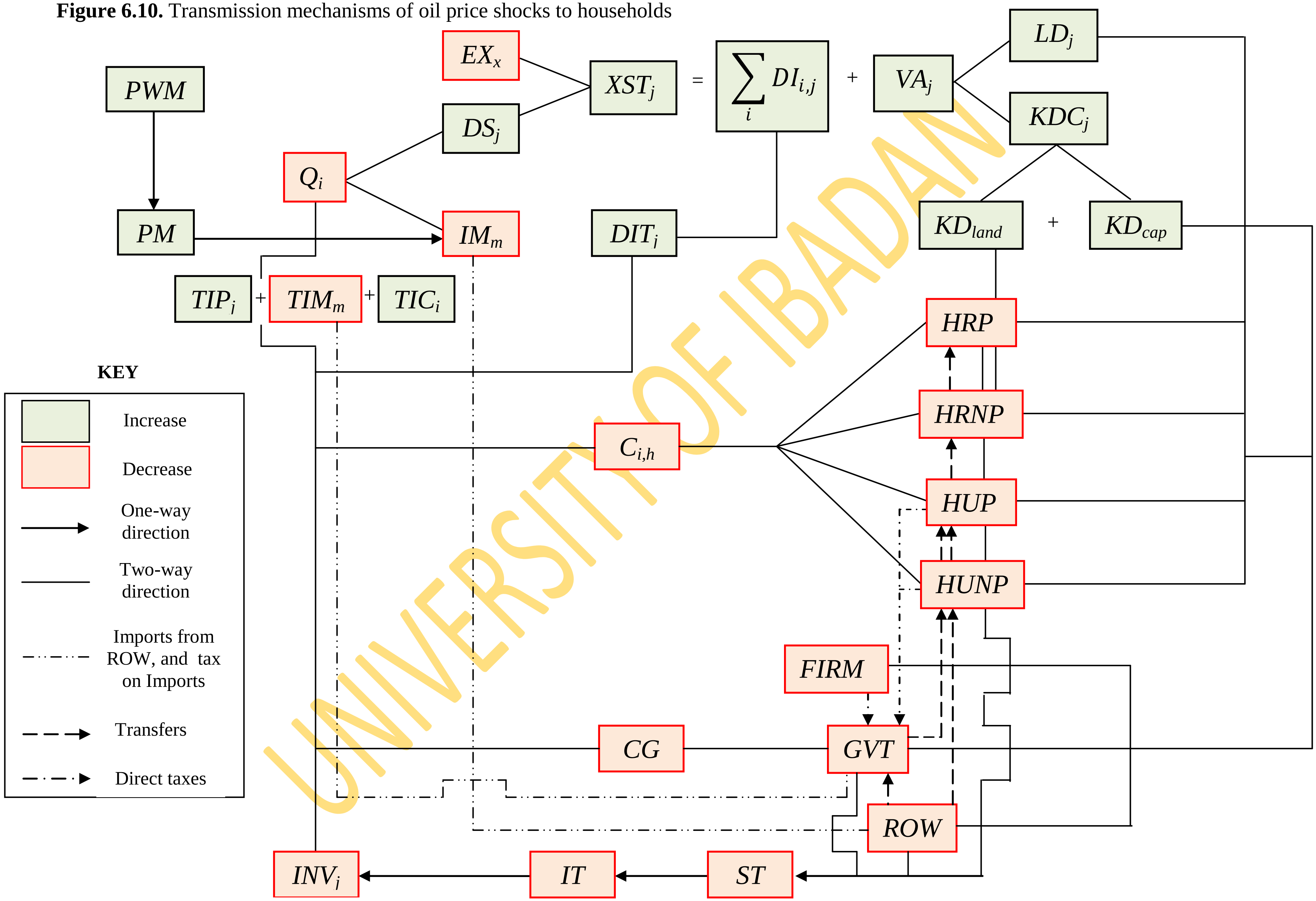
From the government side, increase in the international price of refined oil reduced government's total revenue due, not only, to increase in the real value of subsidy on petroleum[96] but more also to fall in household incomes which ultimately resulted to reduction in direct tax revenue received by the government. With fixed government expenditure, and falling income, government savings (*SG*) decline. The negative effect on government's income reduced its transfer income to households.

The decrease in government's and households' savings, as well as savings from the rest of the world drastically reduced total investment, investment-demand, and ultimately composite commodity from which households derive their consumption.

This discussion is schematically represented by Figure 6.10 below.

[96] This is, notwithstanding the fall in imports of refined oil.

Figure 6.10. Transmission mechanisms of oil price shocks to households



Source: Author's initiative based on the model and simulation results

6.5 Fiscal Policy Response to Shocks

This section presents the results of three additional simulations relating to government's policy response/reforms as measures to mitigate the impacts of the shocks. The first, S4FOOD, considers a 50% reduction in import tax on food in an environment that is faced with a 37% shock to the international price of food. The second and third simulations - S4OILa and S4OILb consider a complete removal of fuel subsidy and a gradual elimination of fuel subsidy respectively both in the event of a 60% increase in the international price of refined oil. Discussions on S4FOOD are made in comparison with S1FOOD, while discussions on S4OILa and S4OILb are made in comparison with themselves and S2OIL1.

6.5.1 Food price shock with 50% reduction in import tax

The simulation results presented in Table 6.12 shows that with a reduction in tariff on food imports, total income of all household categories decline from their base year values. On average, poor rural households' total income declined by 0.67%, while their urban counterpart's income declined by 0.70%. The non-poor rural and urban households also had income short-falls of about 0.52% and 0.64%, respectively. This result contrasts with the households' total income effect where there was no cut on tariff by the government. In S1FOOD households' total income were observed to increase from their base year values.

The negative effects on households' income in the current scenario are not surprising since a cut in tariff on food imports reduced the contraction in food imports. Without the cut, food import is observed to fall by about 40% in the first period, and by 41% in the fifth period. However, with the cut in tariff, Table 6.13 shows that food import declined by only 9.84% in the first period, and by 10.42% in the fifth period. On average, the fall in imports of food was less (10.12%) when government intervened by reducing food's import tax, compared to the case of no government policy response to the shock. This is expected given that the margin between the import price and domestic has been reduced; but, the import price remained higher than the domestic price. Although, there was no strong incentive to increase domestic production as import prices were not much higher than domestic prices, the higher import price over domestic price increased the demand for home production, thus, raising domestic food production by only 0.65% on average.

Table 6.12. Total income of type *h* households (YH)

	Total income of type *h* households (YH)			
	RP	RNP	UP	UNP
1	-0.34	-0.18	-0.38	-0.29
2	-0.48	-0.33	-0.52	-0.44
3	-0.65	-0.5	-0.68	-0.61
4	-0.83	-0.69	-0.86	-0.81
5	-1.04	-0.91	-1.06	-1.03
Av	***-0.67***	***-0.52***	***-0.7***	***-0.64***
	Capital income of type *h* households (YHK)			
	RP	RNP	UP	UNP
1	-0.03	-0.03	-0.13	-0.13
2	-0.23	-0.23	-0.35	-0.35
3	-0.45	-0.45	-0.6	-0.6
4	-0.71	-0.71	-0.89	-0.89
5	-0.99	-0.99	-1.22	-1.22
Av	***-0.48***	***-0.48***	***-0.64***	***-0.64***
	Labour income of type *h* households (YHL)			
T	RP	RNP	UP	UNP
1	-0.42	-0.42	-0.42	-0.42
2	-0.56	-0.56	-0.56	-0.56
3	-0.72	-0.72	-0.72	-0.72
4	-0.89	-0.89	-0.89	-0.89
5	-1.09	-1.09	-1.09	-1.09
Av	***-0.74***	***-0.74***	***-0.74***	***-0.74***
	Transfer income of type *h* households (YHTR)			
	RP	RNP	UP	UNP
1	-0.1	-0.1	-0.1	-0.1
2	-0.13	-0.13	-0.13	-0.13
3	-0.15	-0.15	-0.15	-0.15
4	-0.18	-0.18	-0.18	-0.18
5	-0.21	-0.21	-0.21	-0.21
Av	***-0.15***	***-0.15***	***-0.15***	***-0.15***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.13. Quantity of product m imported (IM)

T	*FOOD*	*OCROP*	*LIVE*	*OTHERAGR*	*MAN*	*COIL*	*ROIL*	*OMIN*	*TRANSP*	*SER*
1	-9.84	-0.85	-1.74	-0.63	-1.42	0.00	-0.22	-0.32	-0.25	-1.27
2	-9.97	-0.96	-2.26	-0.80	-1.81	-0.03	-0.25	-0.55	-0.34	-1.56
3	-10.10	-1.08	-2.85	-0.98	-2.25	0.00	-0.30	-0.80	-0.44	-1.88
4	-10.25	-1.22	-3.5	-1.20	-2.75	0.07	-0.37	-1.08	-0.55	-2.24
5	-10.42	-1.38	-4.25	-1.44	-3.32	0.18	-0.45	-1.39	-0.68	-2.65
Av	***-10.12***	***-1.10***	***-2.92***	***-1.01***	***-2.31***	***0.04***	***-0.32***	***-0.83***	***-0.45***	***-1.92***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

The households' income effects as well as the marginal increase in domestic food production and decline in the output of other sectors such as manufacturing, transport and other agricultural subsectors (see Table D in Appendix E3) are reflective of the negative effects of the shock on capital and labour income due from declines in returns to these factors (see Table E and F in Appendix E3) as well as the shifts in production factors to the more productive food sector. For instance, Table 6.12 indicated that capital income declined by 0.48% for rural households and by 0.64% for urban households, while labour income declined by 0.74% across all household categories. Transfer incomes declines also contributed to the fall in household incomes.

On the consumption side, the total consumption effect for each household suggests that the reducing food import tax is distributionally progressive. This implies a narrowing of the consumption gap between the poor and the non-poor because the total consumption of rural and urban poor households correspondingly declined by 0.75% and 0.34% respectively (Table 6.14) compared with the 1.43% and 0.82% experienced in the scenario without reduction in tariff on food import (S1FOOD). Rural and urban non-poor households consumption declined by 0.6% and 0.33% respectively. Thus, the cut in tariff on food import did not favour the non-poor households.

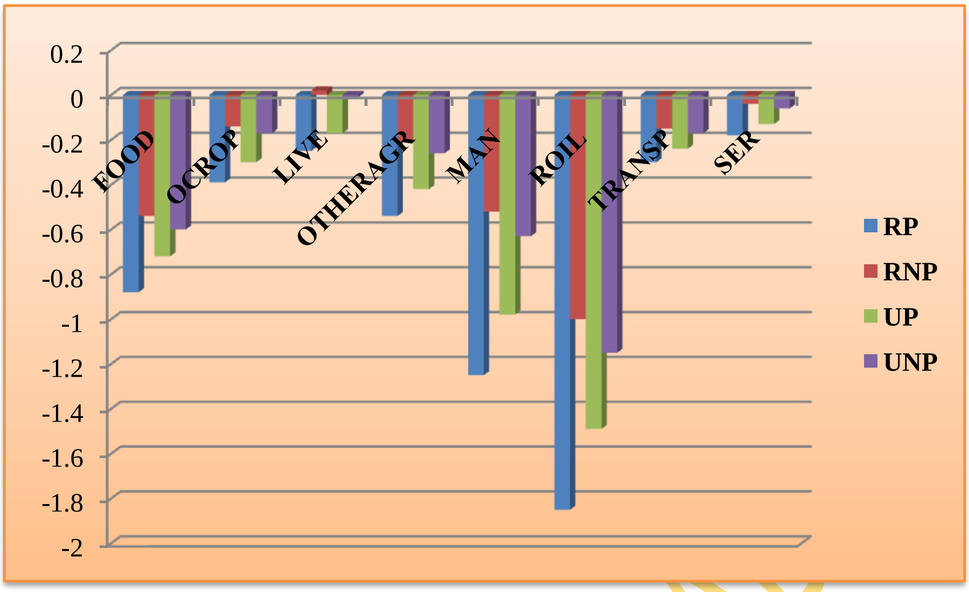
Specifically, Figure 6.11 shows that the reduction in the import tax on food reduced poor rural poor households' food consumption by 0.88%. Their consumption of livestock declined by 0.39%; but this is an improvement compared to the effects when there was no food import tariff reduction, their consumption of other agricultural products declined. Less negative implication on food consumption was also registered by non-poor rural households (-0.54%), poor urban households (-0.72%), and non-poor urban households (-0.6%). Figure 6.11 also shows that non-poor rural households' consumption of livestock increased by a meagre 0.02% - a significant decline from positive 0.37 recorded in S1FOOD. Other household categories consumption of livestock, although negative, was an improvement from the case where there was no reform on food's import tax.[97] Also, as with the poor rural households, their consumption of other agricultural commodities declined more than in S1FOOD.

[97] It should, however, be recalled that the share of livestock in each households' consumption is very small; in fact, less than 1%

Table 6.14. Household consumption effects of food shock with 50% food tariff reduction

T	RP	RNP	UP	UNP
1	-0.46	-0.04	-0.32	-0.04
2	-0.58	-0.17	-0.44	-0.17
3	-0.73	-0.32	-0.58	-0.31
4	-0.89	-0.49	-0.73	-0.47
5	-1.08	-0.68	-0.91	-0.66
Av	***-0.75***	***-0.34***	***-0.60***	***-0.33***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average



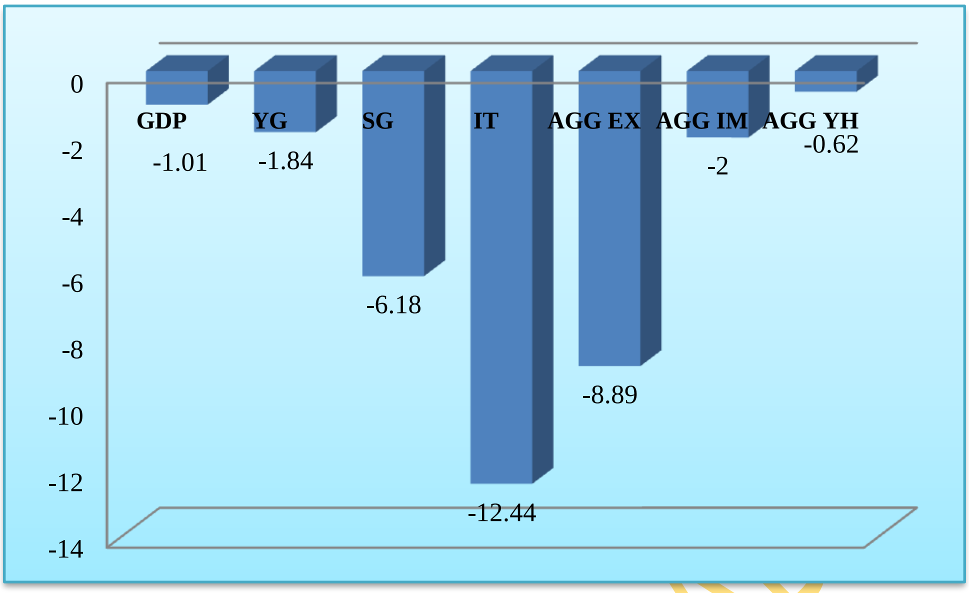
Source: Results from the CGE model
Note: Values represent percentage changes from base year value

Figure 6.11. Consumption of commodities by households for fiscal policy response to food price shocks

In contrast to the scenario with no innovation to food import taxes, all households' consumption of manufactured goods, refined oil, services, and transport goods declined. This clearly reveals that with a shock to the international price of food, a policy of reducing import tax on food mainly favours the consumption of agricultural commodities as households are able to switch consumption among available substitutes that are relatively cheaper. This result is in tandem with the study of Valero-Gil and Valero (2008) who found that subsidies and reduction in tariffs (on some agricultural products) reduced, though marginally, the full impact of food price increase on Mexican households' consumption. Also, Wood *et al.*, (2009), by allowing for substitution within consumer food budgets found that households with substitution options recover some portion of their food budget.

The policy of reducing food import tariff by 50% in the face of a 37% increase in the international price of food is not favourable for the macro economy. GDP, total investment and aggregate household income declined by 1.0%, 12.4% and 0.62% respectively (Figure 6.12) unlike the food shock scenario with no government intervention (S1FOOD) where GDP, total investment and aggregate household income increased.

Other macro variables of interest also declined significantly from their base year values compared to the scenario where there was no government intervention. For instance, government revenue fell by 1.8% which is greater than the 0.3% decline in the S1FOOD scenario. This is partly due to the decline in a component of government revenue - import tax. The short-fall in government revenue reduced its savings, since its expenditure is fixed in the model. The first period fall in government savings was about 4.6%, and by the fifth period it was about 8%. In the fifth period of S1FOOD, the effect of the shock on government savings was 1.5%. This huge decline in government savings also contributed to the effects on total investment. Total investment is seen to decline here by about 12.4% (which is almost twice the fall in government savings), suggesting a fall in private savings. Aggregate export and imports also were negatively affected by the shock, declining by 8.89% and 2% respectively.



Source: Results from the CGE model
Note: Values represent percentage changes from base year value. GDP = Gross Domestic Product; YG = Government Revenue; SG = Government Savings; IT = Total Investment; EX = Aggregate Export; IM = Aggregate Import; YH = Aggregate Household Income

Figure 6.12. Macroeconomic effects of food price shocks with 50% tariff reduction

6.5.2 Oil price shock with alternative policy on subsidy

It is observed that the policy of removing petroleum subsidy reduced the negative effects of increase in the international price of refined oil on households' income. The simulations results (Table 6.15) show that with a one-shot implementation of the policy-shift, total income fell by 5.22%, 4.45%, 4.75% and 3.28% for poor rural, non-poor rural, poor urban and non-poor urban households respectively. These negative effects are lower than the 5.84%, 5.04%, 5.34% and 3.82% experienced by these households when the policy reform was implemented gradually over the simulation period. Since labour income represents a major part of households' income, the decline in wages attributed to the low labour absorption in refined oil sector contributed largely to the decline in households' total income. The negative effects of the policy shock on capital income and transfer income were also less than the effects recorded when there was no policy reform in domestic oil pricing.

As in the scenario with government's provision of subsidy to the domestic consumption of refined oil, consumption of food declined for all household categories. The negative impact was, however, more when petroleum subsidy was gradually faced out, correspondingly declining by 1.69%, 0.99%, 1.24% and 0.32% for rural poor, rural non-poor, urban poor and urban non-poor households (Table 6.16). With a complete removal of subsidy, food consumption declined by 1.48%, 0.85%, 1.09% and 0.23% for rural poor, rural non-poor, urban poor and urban non-poor households respectively. In both S4OILa and S4OILb, consumption of other crops, although negative, improved for all households compared to the scenario where government subsidized domestic consumption of petroleum. With the exception of poor rural and urban households' consumption of other agricultural commodities, consumption of other agricultural commodities for all household types improved in S4OILb.

Across all households, consumption of manufactured goods, refined oil, services, and transport goods declined from their base year values. When compared with S2OIL1, a one-shot complete removal of petroleum subsidy reduces the negative effects on consumption of manufactured goods across all household categories, while a gradual removal of the subsidy increases the negative effects.

Table 6.15. Households' income effects of subsidy removal on oil price shocks

	Total income of type *h* households (YH)							
	RP		RNP		UP		UNP	
T	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb
1	-8.82	-8.28	-7.64	-7.19	-8.06	-7.59	-5.67	-5.41
2	-4.16	-5.07	-3.52	-4.36	-3.81	-4.66	-2.67	-3.34
3	-4.31	-5.25	-3.65	-4.53	-3.93	-4.81	-2.7	-3.45
4	-4.41	-5.3	-3.72	-4.58	-3.99	-4.84	-2.7	-3.46
5	-4.4	-5.28	-3.71	-4.56	-3.97	-4.81	-2.64	-3.42
Av	***-5.22***	***-5.84***	***-4.45***	***-5.04***	***-4.75***	***-5.34***	***-3.28***	***-3.82***
	Capital income of type *h* households (YHK)							
	RP		**RNP**		**UP**		**UNP**	
T	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb
1	-7.62	-7.11	-7.62	-7.11	-0.34	-0.48	-0.34	-0.48
2	-3.63	-4.46	-3.63	-4.46	-0.35	-0.59	-0.35	-0.59
3	-3.77	-4.69	-3.77	-4.69	-0.16	-0.64	-0.16	-0.64
4	-3.85	-4.81	-3.85	-4.81	0.01	-0.66	0.01	-0.66
5	-3.84	-4.85	-3.84	-4.85	0.17	-0.64	0.17	-0.64
Av	***-4.54***	***-5.18***	***-4.54***	***-5.18***	***-0.13***	***-0.6***	***-0.13***	***-0.6***
	Labour income of type *h* households (YHL)							
	RP		**RNP**		**UP**		**UNP**	
T	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb
1	-9.36	-8.78	-9.36	-8.78	-9.36	-8.78	-9.36	-8.78
2	-4.44	-5.37	-4.44	-5.37	-4.44	-5.37	-4.44	-5.37
3	-4.6	-5.55	-4.6	-5.55	-4.6	-5.55	-4.6	-5.55
4	-4.7	-5.6	-4.7	-5.6	-4.7	-5.6	-4.7	-5.6
5	-4.7	-5.57	-4.7	-5.57	-4.7	-5.57	-4.7	-5.57
Av	***-5.56***	***-6.17***	***-5.56***	***-6.17***	***-5.56***	***-6.17***	***-5.56***	***-6.17***
	Transfer income of type *h* households (YHTR)							
	RP		**RNP**		**UP**		**UNP**	
T	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb
1	-3.83	-3.89	-3.83	-3.89	-3.83	-3.89	-3.83	-3.89
2	-1.1	-1.76	-1.1	-1.76	-1.1	-1.76	-1.1	-1.76
3	-1.11	-1.68	-1.11	-1.68	-1.11	-1.68	-1.11	-1.68
4	-1.11	-1.54	-1.11	-1.54	-1.11	-1.54	-1.11	-1.54
5	-1.06	-1.37	-1.06	-1.37	-1.06	-1.37	-1.06	-1.37
Av	***-1.64***	***-2.05***	***-1.64***	***-2.05***	***-1.64***	***-2.05***	***-1.64***	***-2.05***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

Table 6.16. Consumption of commodities by households for subsidy removal to oil price shocks

		RP	RNP	UP	UNP
FOOD	S4OILa	-1.48	-0.85	-1.09	-0.23
	S4OILb	-1.69	-0.99	-1.24	-0.32
OCROP	S4OILa	-0.79	-0.30	-0.51	0.38
	S4OILb	-0.99	-0.43	-0.65	0.30
LIVE	S4OILa	-0.77	-0.19	-0.45	0.71
	S4OILb	-0.85	-0.22	-0.47	0.75
OTHERAGR	S4OILa	-2.18	-1.32	-1.64	-0.54
	S4OILb	-2.47	-1.51	-1.85	-0.68
MAN	S4OILa	-6.84	-4.52	-5.34	-2.97
	S4OILb	-7.54	-5.02	-5.86	-3.35
ROIL	S4OILa	-68.44	-53.86	-57.74	-57.58
	S4OILb	-68.25	-53.66	-57.52	-57.23
TRANSP	S4OILa	-3.02	-2.23	-2.47	-2.06
	S4OILb	-3.14	-2.31	-2.56	-2.12
SER	S4OILa	-1.55	-1.05	-1.22	-0.76
	S4OILb	-1.60	-1.08	-1.25	-0.75

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

On the aggregate, that consumption of rural poor, rural non-poor, urban poor, and urban non-poor households fell by 2.49%, 2.41%, 2.81%, and 2.11%, respectively, when government implements a one-shot removal subsidy on petroleum (see Table 6.17). The negative impacts were higher when government gradually implements the policy, about 2.75%, 2.65%, 3.03% and 2.25% respectively rural poor, rural non-poor, urban poor and urban non-poor households. When compared with S2OIL1, the one-shot complete removal of petroleum subsidy worsens rural poor and urban non-poor households' consumption by an additional 0.04% and 0.10% respectively. From all three case-scenarios (S2OIL1, S4OILa, and S4OILb) it is apparent that: (i) subsidizing the domestic petroleum consumption favours rural and urban poor households (in terms of their consumption)[98] as well as urban non-poor households; (ii) the one-shot removal of petroleum subsidy produces less adverse consumption effects on rural non-poor households compared to other scenarios; (iii) a gradual removal of petroleum subsidy worsens the consumption effects of households in the face of oil price shock.

Over all, the results indicate that poor households, especially rural poor, had the highest negative impact in terms of their income and consumption. This is not far from the findings of Coady *et al.*, (2006), Oktaviani *et al.*, (2005), and Yusuf and Ramayandi (2008) which found that income of the poor household declined the most following the removal of petroleum subsidy. The effects on households' income and consumption are expected given the effects of the shock and policy options on households' sources of income. Intuitively, these shocks decreases the welfare of households given the short-falls in their consumption; and thus, increase the poverty situation of all household categories since there is both a rise in commodity prices following the shock, and a fall in the incomes of all the households, all things being equal.

[98] This does not imply that the consumption effects of poor households are positive but that they are less adverse.

Table 6.17. Household consumption effects of oil price shock with subsidy removal

	RP		RNP		UP		UNP	
	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb	S4OILa	S4OILb
1	-3.23	-2.97	-3.25	-2.90	-3.72	-3.36	-2.44	-2.10
2	-2.21	-2.44	-2.10	-2.31	-2.49	-2.70	-2.00	-2.03
3	-2.29	-2.64	-2.19	-2.53	-2.57	-2.90	-2.03	-2.22
4	-2.34	-2.78	-2.25	-2.69	-2.62	-3.05	-2.04	-2.38
5	-2.36	-2.89	-2.27	-2.82	-2.64	-3.15	-2.04	-2.50
Av	***-2.49***	***-2.75***	***-2.41***	***-2.65***	***-2.81***	***-3.03***	***-2.11***	***-2.25***

Source: Results from the CGE model
Note: T=Time period (from 2006-2011, with 2006 being the base-year); Av=Average

At the macro level, given a 60% rise in the international price of refined oil, a one-shot complete removal or gradual removal of petroleum subsidy (S4OILa and S4OILb) bring about a reduction in all but one macroeconomic variable of interest - government savings (see Figure 6.13). A one-shot complete removal of subsidy on domestic consumption of refined petroleum increases governments' savings over time, by 3.38% in the first period and up to 6.31% in the fifth period. On average, government savings increased by 5.15%. A gradual implementation of the policy-shift decreases government savings in the first period by about 2.56%. It, however, became positive in the second period and by the fifth period it was about 3.62%. On average, government savings increased by 1.11% (much lower than the savings accumulated with a shot-implementation of the policy reform).

It can be seen that despite increases in government savings, total investment declined by 0.1%, on average, with a complete removal of the subsidy, and by 8.5% with a gradual removal. The marginal decline in total investment experienced in the scenario where subsidy is completely removed in the first period can be explained by the huge negative effect (-9.74%) recorded in the first period. From the second period onwards the effects on total investment is seen to be positive. For S4OILb, the average negative effect suggested that other components of the investment build-up[99] declined significantly to have forced total investments down. However, it is interesting to note that these declines in total investment are much lower than what was obtained when government subsidized the consumption of petroleum. Also, it is important to note that the difference in the magnitude of the effects on total investment in the two policy approaches draws from the fact that the first approach (one-shot complete removal of subsidy) frees up tied funds immediately for investment while the other slowly accumulates the savings for investment.

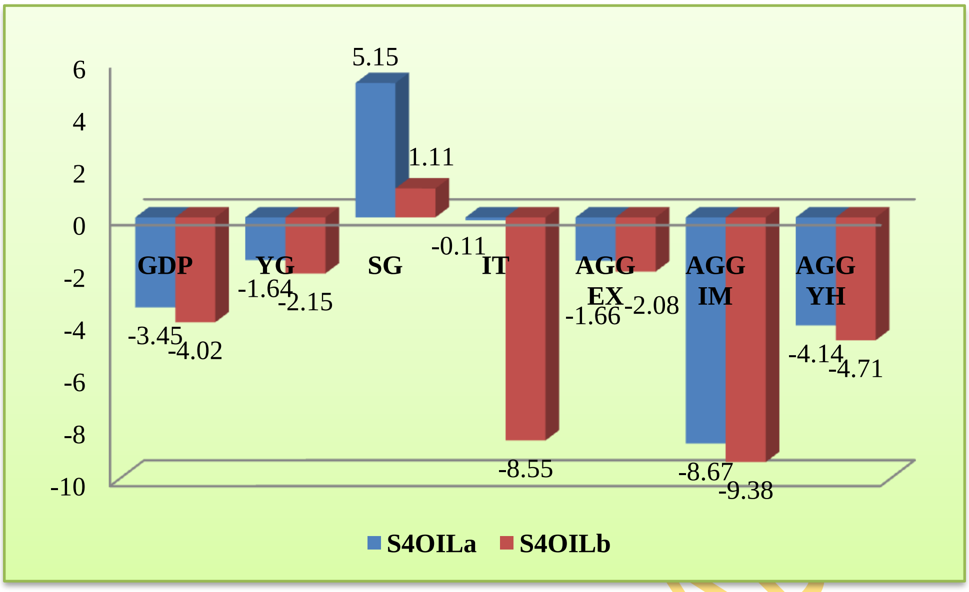
With a one-shot complete removal of subsidy, GDP declined by 5.66% in the first period. The negative effect reduced to 2.92% in the second period, and by the fifth period it declined by 2.84%. On average, GDP fell by 3.45%. This fall is less than the average fall of 4.02% when petroleum subsidy was gradually faced out over the simulation period.

[99] Such as household savings and savings from the Rest of the World

Government revenue declined in the first period by 2.23% and 2.35% with a complete removal (S4OILa) and gradual reduction of the subsidy (S4OILb) respectively. These declines are larger compared to the 1.35% fall experienced in the first period of S2OIL1. On average, the decline in government revenue is lowest (1.64%) when fuel subsidy is completely removed (at once) compared to other oil shock scenarios.

Finally, both aggregate import and export declined in all oil shock case-scenarios but at varying magnitude. With a complete removal of subsidy total exports falls by 1.66% while it falls by 2.08% with a gradual implementation of the policy-shift. However, in the scenario without any reform to the policy of subsidizing domestic consumption of refined oil, aggregate export falls by 2.69%. Similar pattern is also observed in the case of aggregate import. Import declined by 8.67% and by 9.38% with a complete and gradual removal of subsidy removal, respectively; but by 9.58% with the reform.

These results are at variance with the findings of Larsen and Shah (1992), Clarke and Edwards (1997), Saunders and Schneider (2000), Jensen and Tarr (2002), Hartono and Resosudarmo (2006), Burniaux *et al.*, (2009), Breisinger *et al.*, (2011), which found that economic effects (as measured by changes in GDP) increased with the removal of subsidy of fuel consumption. This is, however, not surprising given that, unlike the other studies, the policy reform in this study is observed in an environment perturbed by a 60% increase in the international price of refined oil. The result is also quite different from Ajakaiye and Fakiyesi (2009), who found that with an oil shock simulation of 63.4%, GDP deteriorated cumulatively by 5.43%. Their analysis was, however, considered in an environment where government subsidized the domestic consumption of petroleum.



Source: Results from the CGE model
Note: Values represent percentage changes from base year value. GDP = Gross Domestic Product; YG = Government Revenue; SG = Government Savings; IT = Total Investment; EX = Aggregate Export; IM = Aggregate Import; YH = Aggregate Household Income

Figure 6.13. Macroeconomic effects of oil price shocks with alternative subsidy policy

6.6 Diagnostic check and sensitivity analysis

Some diagnostic checks were carried out to determine the goodness of the overall model specification. In addition, sensitivity analyses (SA) were conducted to check the robustness of simulation results under different parameter values, particularly the CES.[100] The sensitivity analyses were implemented on the S1FOOD and S2OIL1 since they are the benchmark for other simulations.

6.6.1 Diagnostic check

Diagnostic 1 – *Baseline simulation*, to check that the solution to the model (without any shock) reproduces the initial equilibrium value. This was done by comparing the output of the baseline simulation with the database. An alternative was to check the magnitude of infeasibility at the input point from the output file. The result shows that the input point for both S1FOOD and S2OIL1 are infinitesimally small (see Table 1 in Appendix G). This means that the highest deviation of the baseline simulation value from the initial equilibrium value is negligible, and does not bloats the simulation results. In addition, it is expected that the baseline simulation should be solved without any iteration. This was also achieved in the experiment. As can be seen, in Table 1 of Appendix F, there was no iteration beyond "After-scaling".

Diagnostic 2 – *Leon*, to check that the last market is in equilibrium. The check verifies that the Walras law[101] is not violated. This requires investigating the 'level' value of the Leon variable in the baseline simulation and in the shocked simulation. It is expected that the Leon value be zero or tending towards zero (that is, infinitesimally small). The check shows that the values of Leon at baseline simulation as well as the simulated food and oil price shocks were approximately zero (see Table 2 of Appendix F).

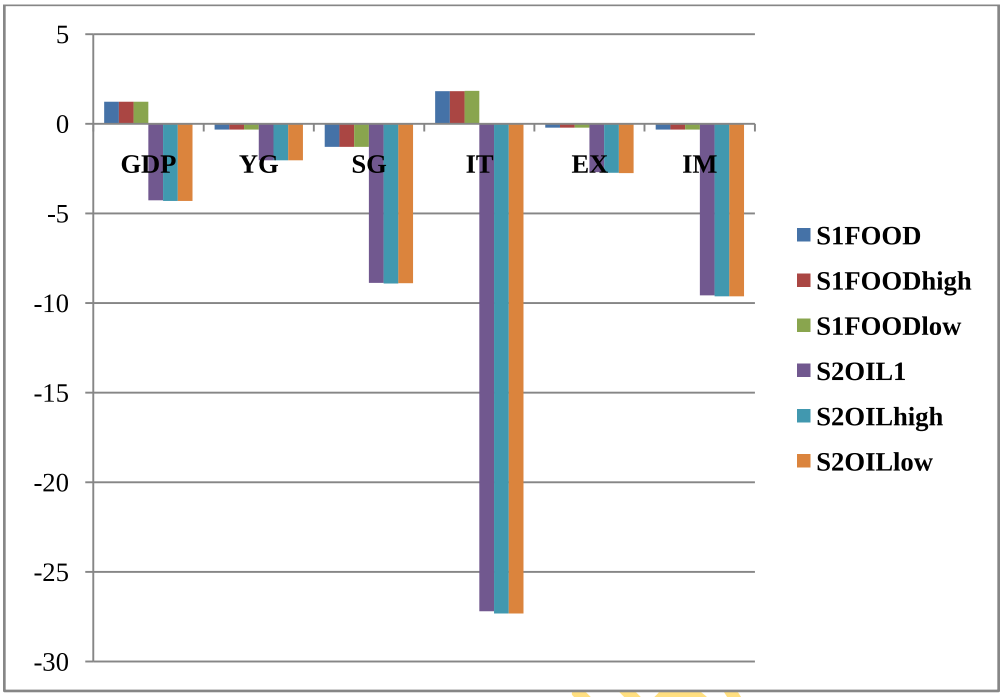
6.6.2 Sensitivity analysis

The sensitivity analysis was done by varying the CES values systematically and investigating the results.[102] First, the initial values of CES were doubled, and then reduced by halve. This was intended to analyse how sensitive the results were to these large changes. For verification, the results for macroeconomic and household total

[100] A full sensitivity examination of all the assumptions in the model would be virtually impossible; thus, emphasis is on the CES given that it was borrowed from the literature, and it is usually the benchmark sensitivity analysis carried out in CGE studies.
[101] The Walras law states that if *n-1* market is in equilibrium, then the last market is also in equilibrium.
[102] It should be noted that the CES investigated relates with those that were assigned arbitrarily from values obtained in the literature such as capital demand, labour demand, imports, and value added; not those that were calibrated from within the system.

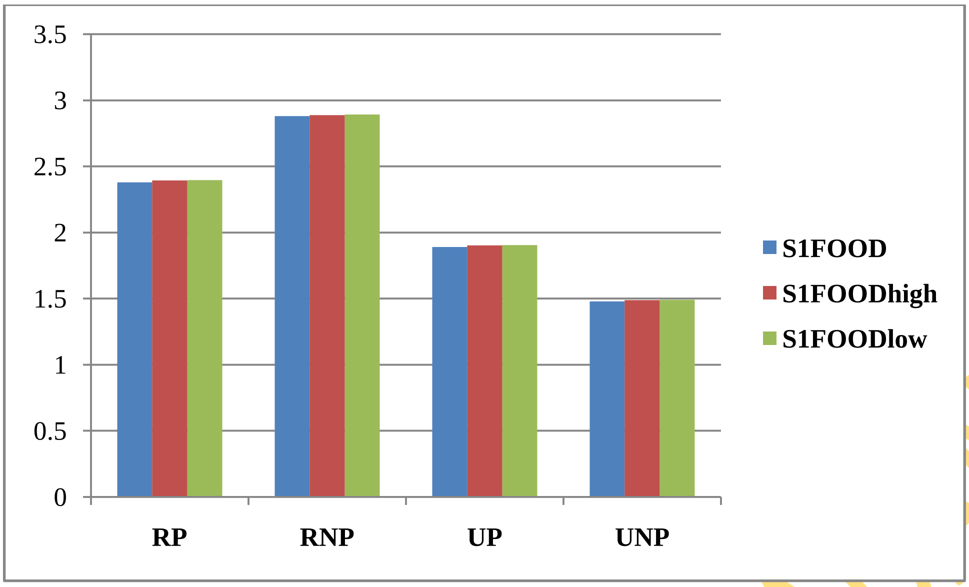
income[103] and consumption variables are presented only. The results generally show that the model is relatively stable as changes in the CES do not influence the simulation results significantly. For instance, most macro variables of interest such as GDP, government savings, and aggregate import showed no deviation from the original simulation (S1FOOD) when CES were doubled as well as when CES were reduced. For the oil shock simulation, it was observed that GDP, total investment and aggregate imports show some deviations above 0.01 (but less than 0.05) from the original simulation (S2OIL1) (see Figure 6.14). Households' income also did not show any significant deviation from the results obtained when the standard assumption made about the CES was employed. For the food shock scenario the highest deviation was about 0.02 (S1SAlow) from the standard simulation (S1FOOD), while it was about 0.07 (S2SAlow) in the oil shock scenario (see Figure 6.15a and 6.15b).

[103] Rather than present the systematic analysis results for all sources on households income, only total income is presented because any deviation in the SA results implies deviations in one or more sources of households total income.



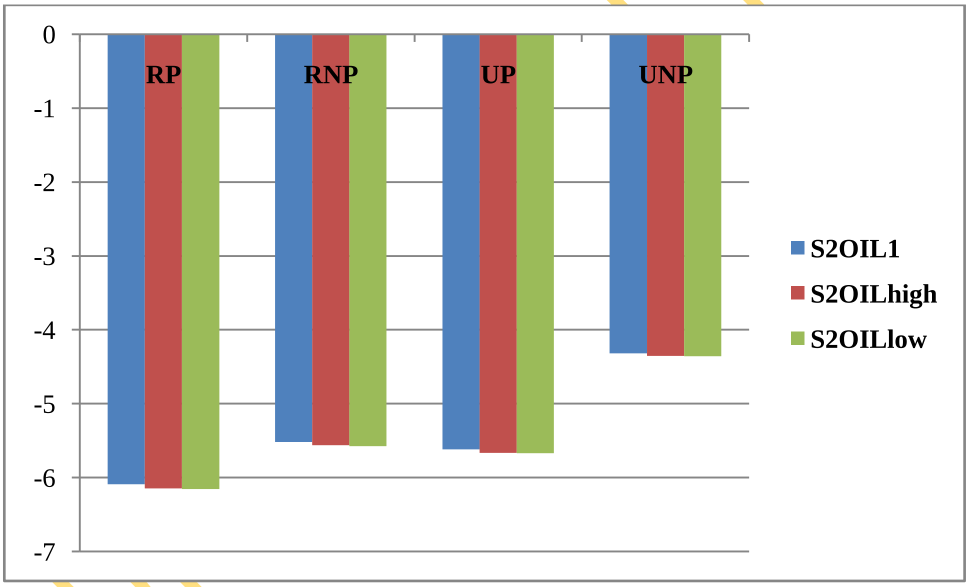
Source: Based on Simulation results from the CGE model
Note 1: S1FOODhigh and S2OILhigh refer to doubled CES elasticity, while S1FOODlow and S2OILlow refer to results from halving the CES.
Note 2: Values represent percentage changes from base year value. GDP = Gross Domestic Product;
YG = Government Revenue; SG = Government Savings; IT = Total Investment;
EX = Aggregate Export; IM = Aggregate Import

Figure 6.14. Sensitivity analyses on macroeconomic variables food and oil shock simulation



Note: S1FOODhigh refer to doubled CES elasticity, while S1FOODlow refer to results from halving the CES.

Figure 6.15a. Sensitivity analyses of household total income on food simulation



Note: S2OILhigh refer to doubled CES elasticity, while S2OILlow refer to results from halving the CES.

Figure 6.15b. Sensitivity analyses of household total income on oil simulation

6.7 Concluding remarks

In this chapter, the results obtained from the CGE analysis of food and oil price shocks on the Nigerian households were presented and discussed. It is noteworthy that the simulation experiments conducted in relation to 37% increase in the international price of food, and 60% and 37% in the international price of refined oil have shed considerable light on the implications of food and oil price shocks in the Nigerian economy at macro level, sectoral level and, more importantly, at household level. The channels via which these shocks are transmitted to households were also discussed. Furthermore, the effects of government intervention in the shock process through changes in some of its policy were also investigated.

The results suggest that a positive shock to the international price of food generate higher income for all households but decreases consumption of all household categories except the non-poor households whose consumption increased, although marginally. On the other hand, a positive shock to the international price of refined oil is unfavourable to the households in Nigeria both in terms of their income and consumption. The poor households are observed to be the worst hit. Even with government efforts to mitigate the adverse effects of the shocks via policy reforms, households (especially, the poor ones) are observed to suffer significant income and consumption losses. The results suggest that, with income of the poor household falling more than the non-poor households, there may be a widening of the income gap between the poor and non-poor. This should warrant active policy interventions in the interim to cushions the effects of the shocks on poor households in particular. In addition, a strategic structural reform is necessary in both the agricultural food sector and refined oil sector if the country and households would benefits from positive shocks to the international price of these commodities.

Finally, the diagnostic check and sensitivity analyses results indicated that some measure of confidence can be placed on the simulation results obtained from the CGE model.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 Introduction

The chapter summarises the main findings of this study, offer some direction for policy, highlight the limitations of this study and shed some light on future directions of research. The chapter is structured as follows. Section 7.2 presents a summary of research findings. Some policy recommendations are presented in Section 7.3. The limitations of the study are discussed in Section 7.4. Section 7.5 highlights suggestions for further research and the final section presents concluding observations.

7.2 Summary of Research Findings

The simulation experiments (in the food shock scenario) suggested an improvement in households' income level. Contraction in food imports outweighed increase in domestic food production, thus, slightly reducing the total food available in the domestic market. The food sector, however, experienced increase in its factor demand given the expansion in domestic production of food. It was observed that the sector's demand for labour and land contributed more than capital in the expansion in domestic food production. This closely reflects the Nigerian case where food production growth has always been driven by expansion in area planted than increase in productivity. The manufacturing sector which contributes about 17% of total intermediate input value of the food sector also experienced increase in its imports. Increases in wage rate and factor returns resulting from factor markets effects are translated to increased households' income. However, households' experienced significant decline in the consumption of some commodities (attributable to higher composite price of those commodities). Urban non-poor households were the least affected while the rural poor households were the worst hit. Non-poor rural household gained from the shock. On aggregate, households' real consumption declined suggesting a negative aggregate welfare loss. At the macro level the results revealed an improvement of about 1.2% in economic growth as measured by GDP. Total investment and aggregate household income were also positively affected by the shock. However, while government income declined, terms-of-trade worsened due to rising aggregate imports over exports.

With a policy intervention of reducing the import tax on food, it was observed that: growth is retarded; other macroeconomic indicators such as total investment, government and household income, and terms-of-trade falls; capital demand declines in all sectors; labour demand increases in most sectors; and households' total income as well as their consumption fall. The implication is that the policy tends to reduce the import price of food, discourage increase in domestic production, and thus, reduce income that could have been gained by increasing local capacities for production. In fact, real consumption of rural and urban non-poor households' worsened compared to the scenario where there was no government intervention while it lessened the adverse effects on poor households' consumption. This suggests that, although the policy of reducing import tax on food does not favour the economy, it is distributionally progressive as it provides some cushioning for poor households. Non-poor households were not favoured by the policy. Thus, this finding is not totally in consonance with the finding of Tomori *et al.* (2005) and Olaniyan (2000) that Nigeria government's policy in dealing with shocks aggravates the impacts.

Results from the oil shock simulations showed that households experienced significant decline in their total income and consumption. As expected, non-poor urban households were the least affected while the poor rural households had the highest decline in income. Total household income declined, on aggregate. Urban poor households had the largest decline in consumption followed by rural non-poor households. Also, key macroeconomic indicators declined. The effects from the two simulations (S2OIL1 and S2OIL2) differed due to the difference in the magnitude of the shock. This corroborates the general findings from the empirical review which suggests that shock-effects depend, among other factors, on the size of the shock. At the industry level, activity in the transport, crude oil, and other mining sector are affected more than other sectors due to their relative intermediate input demand from the refined oil sector. While capital shifts significantly to the refined oil sector, labour demand increased only in the food and other crop sectors, besides the refined oil sector.

One interesting finding from the oil shock simulation result is that, even if the country experiences the same shock magnitude as food, general macroeconomic performance worsened. This, as well as industry and factor market effects, generate declines in households' income and consumption. One plausible explanation adjudged for this is structure of the Nigerian economy in relation to imports and domestic production in the two sectors. While the domestic production of food is more than food import, only a small fraction of refined oil composite is produced domestically.

Furthermore, the results revealed that the removal of petroleum subsidy (gradually - over the simulation period, or completely in the first period) reduced the adverse effects of rising oil prices on the domestic economy and on households. Specifically, it was noted that (i) subsidizing the domestic petroleum consumption favours rural and urban poor households consumption as well as urban non-poor households consumption; (ii) the one-shot removal of petroleum subsidy produced less adverse consumption effects on rural non-poor households compared to other scenarios; (iii) a gradual removal of petroleum subsidy worsens the consumption effects of households in the face of oil price shock.

A combined oil and food shock generated a general decline in all macroeconomic variables of interest. The magnitude of the decline, however, varied from what obtained in the individual shock experiment. For instance, the decline in GDP was less than that of oil price shock scenario. This suggests that the positive gains from food shock tampered off the full effects of the oil price shock on economic growth. This pattern, where the impact of the shocks either offsets the full effects of the shock or reinforces it, was observed in all results obtained in this shock scenario. For instance, households total income which were seen to increase in the food shock scenario, declined in the combined shock experiment but the decline was less than what obtained in the oil shock experiment. This suggests that a development of the food sector (and other agricultural sectors) can help mitigate the full effects of rising oil prices on the Nigerian economy and households.

Finally, the simulation results obtained from the study highlights the importance of factor markets in the transmission of shocks to households in Nigeria. Given that labour constitute the largest share of households' income in Nigeria; it was observed that any perturbation in the steady state general equilibrium of the economy that affects the demand for labour would significantly affect households' income. Also, since their consumption budget is derived from their disposable income, their consumption is also impacted. This is true even with a fixed tax rate. Thus, besides changes in the relative prices of goods, the changes in the relative prices of factors played a significant role in determining households' outcomes.

7.3 Implication for Policy

Based on the research findings obtained from this study, a few recommendations for policy are suggested. There is urgent need to tackle the factors that have impeded agricultural productivity growth (food, in particular), and to promote reforms that would position the country to gain from rising world food prices. In line with this, there is need for a number of interventions including increased investment in agricultural food production (which should involve both public and private partners); improvement in the quality and effectiveness of agriculture sector programmes; and adoption of modern technology and best practices in the agricultural sector.

The need for these interventions is further supported by the result obtained from simulating a reduction in tax on food imports. Rather than implement a general reduction in the import tax on food, the results have highlighted the need for an approach that has both short- and long-term benefits. In addition, it has highlighted the need for targeting policy response given that some household groups are more affected by the shock than others.

There is also the need for government to ensure that existing refineries are functional, at optimum capacity. In addition, new refineries should be set up so as to increase domestic production of refined oil, and thus, reduce dependence on refined oil imports. Being a very capital-intensive sector (with most of the capital owned by foreigners), there is need for policy that would favour local capacities to participate through partnership/shareholding to own capital in this sector so that returns to capital in this sector would be retained. A quick passage of the Petroleum Industry Bill is a step in the right direction.

These suggestions, if pursued, would position the country and households, in particular, to reap the gains from positive shocks to the international prices of these commodities. This is because the suggestions have factored in the vulnerability of the economy to the shocks as well as on the country and its economic agents abilities to adjust dynamically to the shocks.

7.4 Limitations of the Study

Similar to many empirical studies, this study was constrained by a number of factors which could be considered as limitations. The Nigeria SAM does not include features of the financial sector, and as such, the CGE model used in this study focuses on the real side of the economy. The implication is that the effects of the shocks depended only on changes in relative prices, thus underplaying the role of financial markets on economic agents' behaviour.

Also related to the database is the elasticity parameters used in the model. The elasticity parameters used in the model were not econometrically estimated using Nigerian data but have been 'borrowed' from other studies. However, a reasonable level of confidence can be placed on the results from the model simulations, as the results were robust with different CES parameters.

Another limitation of the study was that, as the current model simulated the effects of food and oil price shocks on representative households, it misses out the heterogeneous components of households. More information may be provided with a microsimulation CGE model because of its ability to track inter-household effects of shocks. However, construction of a recursive dynamic microsimulation CGE model for Nigeria is not only severely constrained by data but also computationally challenging.

Despite the aforementioned limitations, the current model along with the modified SAM generated plausible empirical results. Thus, the analysis carried out still proves useful in understanding the household effects of international commodity price shocks.

7.5 Suggestions for further research

The areas of further research that can be identified with respect to the current study are directly or indirectly associated with some of the limitations of the study discussed above.

First, it would be appropriate to divert more resources, time and effort into constructing a comprehensive database for a recent base year that would include activities of the financial sector. This would prove useful in studying how accessibility to credit and possession of financial assets by households can help tamper the effect of international commodity price shocks as they may help households smoothen their consumption path in the face of shocks. Also, although the level of confidence attached to the conclusion of the model simulations is reasonable, there is still the need for elasticity parameters used in the model to be econometrically estimated using Nigerian data.

Second, it is ideal to extend the current CGE model to incorporate features of microsimulation so as to account for households' heterogeneity. This will better capture households' experiences with respect to the shocks they face. Further disaggregation of the number of industries and commodities may prove more useful in understanding the industry level linkages, and the transmission of shocks to households.

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APPENDIX

Appendix A:

Share of Food Expenditure in Household Budget of 23 African Countries (%)

	National	Rural	Urban	Q1	Q5
Ave of 23 African Countries	55	61	48	63	48
Income Level					
Low Income Countries	59	64	50	67	52
Middle Income Countries	45	54	42	51	38
Degree of Urbanization					
Low Urbanization	61	65	48	68	54
Medium Urbanization	60	66	54	67	52
High Urbanization	49	54	45	56	42
Region					
East	64	71	46	73	56
West	53	60	47	62	46
South	57	62	51	66	49
Central	50	55	49	50	45

Source: Household Expenditure Survey Database, Africa Region, The World Bank

Appendix B

Table 1. **Crop sub-sector in the Nigeria SAM and their shares of GDP and agricultural GDP**

Sector/Subsector	GDP (current million Naira)	Share of GDP in 2006 (%)	Share of Ag GDP in 2006 (%)
TOTAL GDP	**19,908,533**		
AGRICULTURE	**5,913,648**	**29.7**	
Crop sub-sector	**5,211,702**	**26.2**	**88.1**
Rice	526,484	2.6	8.9
Wheat	7,160	0.0	0.1
Maize	433,601	2.2	7.3
Sorghum	317,979	1.6	5.4
Millet	248,917	1.3	4.2
Cassava	867,097	4.4	14.6
Yams	782,609	3.9	13.2
Cocoyams	42,397	0.2	0.7
Irish potato	58,693	0.3	1.0
Sweet potato	115,263	0.6	1.9
Banana and plantain	122,092	0.6	2.1
Beans	202,894	1.0	3.4
Groundnuts	213,503	1.1	3.6
Soybeans	223,501	1.1	3.8
Beniseed	21,410	0.1	0.4
Vegetables	395,745	1.8	6.7
Fruits	343,403	1.6	5.8
Cocoa	19,871	0.1	0.3
Coffee	31,353	0.2	0.5
Cotton	15,795	0.1	0.3
Oil palm	91,252	0.5	1.5
Sugar cane	60,197	0.3	1.0
Unprocessed tobacco	29,180	0.1	0.5
Nuts	5,065	0.0	0.1
Cashew	714	0.004	0.0
Rubber	32,050	0.2	0.5
Other unspecified crops	3,477	0.017	0.1

Source: Nwafor *et al.*, (2010)

Table 2: **Trends in Triennial Growth Rate of Production Data (1976-2010)**

	Cassava		**Maize**		**Millet**		**Rice**		**Sorghum**		**Wheat**	
Period	Average Production (metric tonnes)	Growth rate (%)	Average Production (metric tonnes)	Growth rate (%)	Average Production (metric tonnes)	Growth rate (%)	Average Production (metric tonnes)	Growth rate (%)	Average Production (metric tonnes)	Growth rate (%)	Average Production (metric tonnes)	Growth rate (%)
1971-75	9668400		916200		3407200		470200		3375000		18200	
1976-80	11500000	18.9	695200	-24.1	2515600	-26.2	596200	26.8	3026400	-10.3	20800	14.3
1981-85	11308000	-1.7	1107000	59.2	3012800	19.8	1300200	118.1	4063400	34.3	43600	109.6
1986-90	15630000	38.2	4841200	337.3	4374200	45.2	2216064	70.4	5015600	23.4	86200	97.7
1991-95	29545000	89.0	6354600	31.3	4706400	7.6	2979600	34.5	6104200	21.7	42280	-51.0
1996-00	32174000	8.9	5126200	-19.3	5920800	25.8	3248000	9.0	7425600	21.6	77000	82.1
2001-05	36580400	13.7	5242600	2.3	6308200	6.5	3139400	-3.3	8077400	8.8	58200	-24.4
2006	45721000	25.0	7100000	35.4	7705000	22.1	4042000	28.8	9866000	22.1	71000	22.0
2007	43410000	-5.1	6724000	-5.3	8090000	5.0	3186000	-21.2	9058000	-8.2	44000	-38.0
2008	44582000	2.7	7525000	11.9	9064000	12.0	4179000	31.2	9318000	2.9	53000	20.5
2009	36804300	-17.4	7338840	-2.5	4884890	-46.1	3402590	-18.6	5270790	-43.4	36813	-30.5
2010	37504100	1.9	7305530	-0.5	4124560	-15.6	3218760	-5.4	4784100	-9.2	34200	-7.1

Source: Computed by Author; underlying data is from FAO Statistics Division, 2012

Table 3. **Pass-through of food price increases in 2007/08 and 2010/11**

	Cassava	Maize	Millet	Rice	Sorghum	Wheat
	Change in international price in USD*					
June 2007 - June 2008	86%	71%	86%	162%	65%	25%
June 2008 - February 2010	-33%	-42%	-33%	-34%	-39%	-23%
February 2010 - February 2011	49%	77%	49%	-4%	69%	75%
	Change in domestic price in USD					
June 2007 - June 2008	41%	104%	46%	56%	70%	52%
June 2008 - February 2010	-1%	-8%	-16%	-8%	-18%	-15%
February 2010 - February 2011	-3%	3%	-8%	6%	-4%	8%
	Change in domestic price in nominal LCU					
June 2007 - June 2008	34%	89%	27%	38%	49%	38%
June 2008 - February 2010	17%	8%	-5%	8%	-6%	-4%
February 2010 - February 2011	-2%	5%	-7%	8%	-3%	7%
	Change in domestic price in real LCU					
June 2007 - June 2008	22%	74%	18%	27%	36%	26%
June 2008 - February 2010	8%	-3%	-7%	3%	-9%	-10%
February 2010 - February 2011	-8%	-4%	-9%	2%	-6%	2%
	Change in domestic price in real LCU as a share of change in international price in real USD*					
June 2007 - June 2008	28%	116%	23%	17%	62%	144%
June 2008 - February 2010	-22%	7%	19%	-8%	21%	38%
February 2010 - February 2011	-21%	-6%	-23%	-14%	-10%	3%
Number of markets (N=119)	13	32	22	44	7	7
No. of countries (N=14)	6	9	4	11	4	4

Note: *International prices for Cassava and Millet use averages for maize, rice and wheat. International prices are Wheat (US No2, Soft Red Winter Wheat, US Gulf), Maize (US No, Yellow, US Gulf) and Rice (White Rice, Thai 100% B second grade).

Table 4. **Institutional Memory of Agricultural Policies and Program**

Period	**Projects/Program**	**Description**	**Weaknesses**
Colonial period (1900-1960)	Cooperatives (1935 to Date)	The Nigerian Cooperatives Ordinance was promulgated in 1935 to regulate Cooperative activities in the country. In 1974 a law was enacted which established the Department of Cooperatives in 1974.	Policy inconsistency and administrative dislocations of the Federal Department in charge of Cooperatives.
	Commodity Boards (1947 to 1986)	Commodity Marketing Boards started during the colonial era with the establishment of first generation marketing Boards as follows: Cocoa Marketing Board in 1947, Palm Produce, Groundnut and Cotton Marketing Boards 1949. The second generation established in 1954 were the regional marketing boards. They served as buyers of last resort, at fixed prices and held strategic or buffer stock.	Inability to pay farmers the subsisting market price then Scrapped in 1986 under Structural Adjustment Programme.
First Republic period (no Federal Ministry for agriculture) (1960-1966)	Agricultural Research Institutes (1964 to Date)	Four research institutes namely: Cocoa, Oil Palm, Rubber and Trypanosomiasis were established by Nigerian Research Institute Act in 1964. In 1975 the Agricultural Research Institute Decree came into effect where additional Research Institutes were established to conduct research in various crop, livestock and fisheries.	Instability of the Research Institutes as a result of constant movement of the agricultural research institutes from one Ministry to another. There was also a major problem with funding of these Institutes.
First intervening period of military regime (1966-1979)	National Accelerated Food Production Project (NAFPP) (1970s)	Objectives were to increase the yields of seed varieties and enhanced fertilizers use and promoted extension and credit services as well as adaptive research and staff training. A number of national crop centres were established at different locations e.g. Ibadan for rice and maize Zaria for sorghum, millet and wheat and Umudike for Cassava.	Started very well but the wheat programme was affected by a basic withdrawal of political support and lifting of the ban on wheat import.
	Nigerian Agricultural Cooperative Bank, NACB (1973 to Date)	The main specialised institution for agricultural credit delivery in the country.	Directed to provide subsidized credit at single digit interest rate without the corresponding subsidy provided by government. Needs to be reformed for greater efficiency and effectiveness in resource mobilization and credit delivery.

Period	Projects/Program	Description	Weaknesses
	Agricultural Development Projects (ADPs) (1975 to Date)	• World Bank funded at inception • ADP revolution started in 1974 with the establishment of Gombe, Funtua and Gusau ADPs. • There are presently 37 ADPs in all States and the FCT. • Set up to provide extension services, technical input support and rural infrastructure services • ADPs were set up in response to the fall in agric production, and hence a concern to sustain domestic food supplies, as labour had moved out of agriculture into more remunerative activities that were benefiting from the oil boom. • Though they were set up to perform a temporary role in providing advisory services, the ADPs have literally assumed a permanent status. They are now recognized as the major agricultural development institutions in the States.	• **Delays**: The decline in oil prices that started in 1982 had a substantial fiscal effect in Nigeria and led to shortages of counterpart funds for these projects. • **Farming Systems:** The emphasis on modern technology in the ADPs led their agricultural research and extension services to focus on relatively high input technology for sole cropping systems. These systems were not used by the majority of smallholders who used mixed/relay cropping systems as a rational strategy to reduce risks • **Extension Methods**: The change from the training and demonstration system to the T&V system was slow resulting in top down rather than responsive recommendations to farmers and continued technical emphasis without attention to socioeconomics as well as inadequate attention to demonstration plots. • **Input Supplies:** Programs for multiplication of improved seeds generally fell short of goals. Supplies of fertilizers were erratic largely due to centralized government control of international procurement and a very heavy subsidy program. • **Institutional Aspects and Sustainability**: At project closure, most ADPs had a weak and uncertain funding structure and were providing poorer services than should be expected of such semi autonomous development institutions.
	Operation Feed the Nation (1976 to 1979)	This was a mass mobilization and mass awareness program created in 1976 through 1979 in reaction to the first real food crises in the country. The programme ended with the advent of the civilian regime in 1979.	The lack of continuity and shift in approach by successive governments were the reasons for the failure of the poverty alleviation programmes.

Period	Projects/Program	Description	Weaknesses
	River Basin Development Authorities (RBDAs) (1977 to Date)	• The major instrument of the water resources and irrigation policy was the establishment of 11 RBDAs in 1977 to develop and take advantage of available water bodies in the country for agriculture, fishing and other purposes. • Were the main instruments of government's direct agricultural production through large scale mechanized farming. • Had the mandate for land preparation, development of irrigation facilities and construction of dams, boreholes and roads. • Were also involved in the distribution of farming and fishing inputs.	• The failure of the RBRDAS was due to unnecessary political interference and managerial problems resulting from socioeconomic cleavages which permeated the nations socio-political, economic and cultural Institutions. • Lack of qualified manpower to provide effective leadership at the departmental levels. • Inconsistence government policy resulting to increase in the number to 18 in 1984. Although the increase was aimed at decentralizing the authorities and bringing her functions and activities closer to the rural populace, the number was returned back to the former 11 with the coming of another regime.
Second Republic period (1979-1983)	Green Revolution (1979 to 1983)	Launched between1979 and1983, the program focused on food production, input supply and subsidy, special commodity development, review of agricultural credit guarantee scheme and increased resource allocation to RBDAs	The lack of continuity and shift in approach by successive governments were the reasons for the failure of the poverty alleviation programmes. Poverty reduction programmes became more 'regime specific' because there was hardly any continuity with those initiated by previous governments.
Second intervening period of military regime (1984-1999)	Directorate of Foods and Roads and Rural Infrastructure (DFFRI) (1986 -1993)	• DFFRI was established in late 1986 to accelerate the rate of infrastructure development in the rural areas. It was originally designed as supra-ministerial body for channeling the proceeds of the liberalized foreign exchange market for rural development. • It is involved in the provision of rural roads, water supply, electricity and community development services. • The core of the Directorate's programme is the promotion of Productive activities. Besides, the directorate recognized the provision of rural infrastructure such as feeder roads, water, electricity and housing as essential for the enhancement of the quality of life in the rural areas.	• The lack of funds and commitment limited the extent of infrastructural provision in the rural areas. • the government rural infrastructural programmes were embarked upon with limited programme of action and appropriate institutional arrangements for their execution. For instance, government established DFFRI at the Federal Level and only uses the states and the local govts for the disbursements of funds for the implementation of its programmes. • the lack of spatial focus in rural development planning handicapped the rural infrastructural programmes. Usually most villages in the country

Period	Projects/Program	Description	Weaknesses
		For the purpose of the programme implementation, the directorate uses as its main agents, the states and the local governments, to execute its programme. The funds for the programme of the Directorate are made available directly to each state government who then sees to the disbursement of such fund to the local governments. The local governments in the federation are constituted into rural development committees.	are scattered. This raises the problem of threshold population for sustaining the infrastructural provision. For instance, villages where infrastructures like schools and hospitals have been provided before have witnessed the closure of these facilities due to lack of threshold population.
	National Agricultural Land Development Authority (NALDA) (1991 to 1999)	The objectives include providing strategic public support for land development, promoting and supporting optimum utilization of Nigeria's rural land resources, providing gainful employment opportunities for rural people as well as raising incomes and improving general living standards in rural areas.	The NALDA approach increased rather than reduce the direct public provision of goods and services which could have been provided by the private sector instead. Many of NALDA's services were duplications, albeit on a more intensive basis of services provided by ADPs.
Third Republic period (1999-2007)	Presidential Initiatives on select commodities: Cassava, Rice, Vegetable oil, Cocoa, Livestock, Fisheries	A series of initiative of the President targeted at particular commodities to increase food production in line with Vision 2020; with a view to attracting the attention of the highest political authority for special intervention in the commodity sector.	Inadequate funding and lack of institutional arrangements for implementation. The initiatives generated interest and production increased but there were no concurrent provisions for storage and processing resulting in large postharvest losses and apathry on the side of the farmers.

Source: NPC (2009), Report of the National Technical Working Group on Agriculture and Food Security

Table 5. Energy Consumption values in the Nigerian transportation sector from 1980-2010

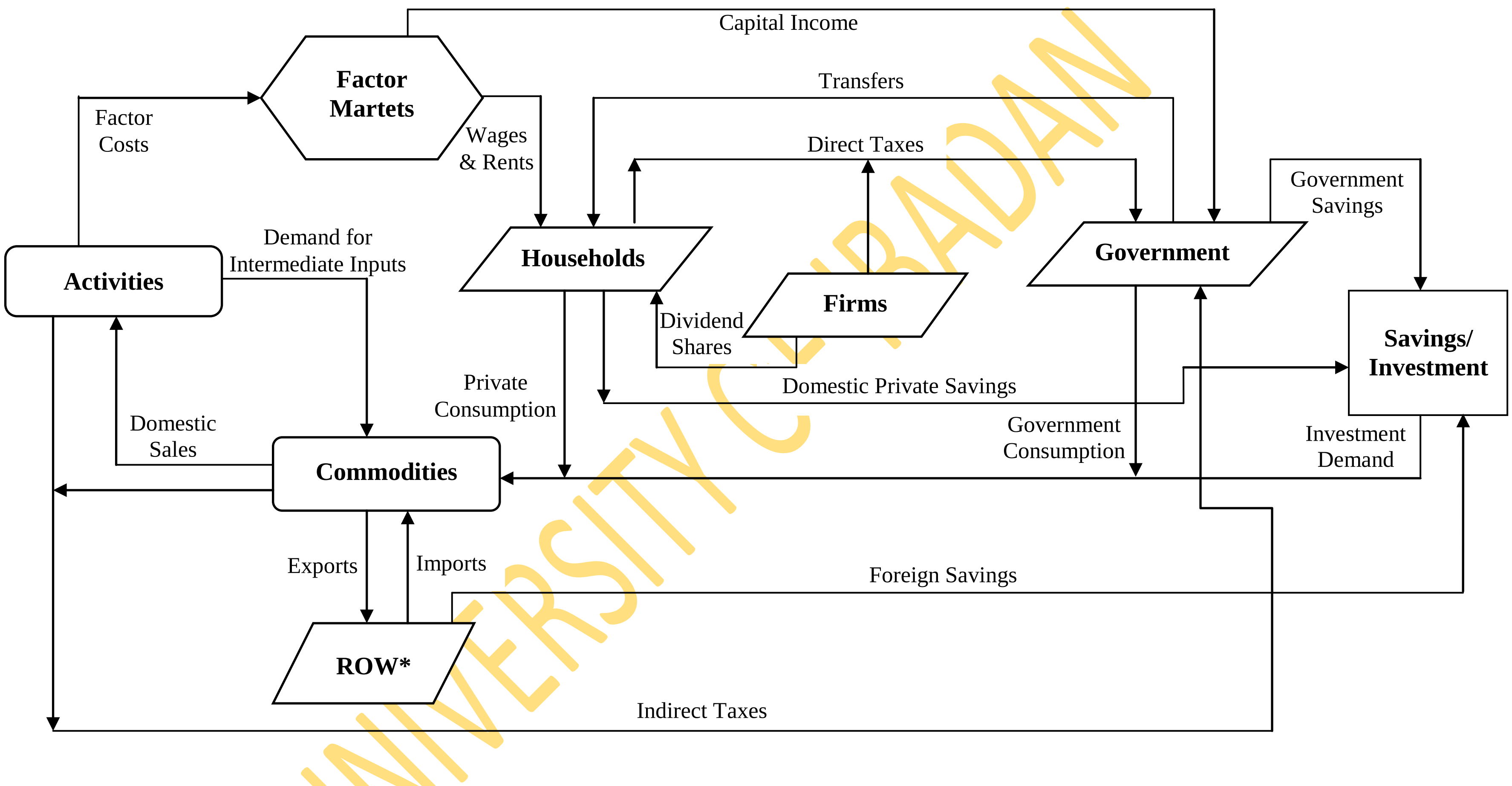
	Land transport				**Total land transport**		**Air transport**		**Marine transportation**				**Total marine transport**		**Railway transportation**		**Annual Total**
	PMS	% of TPC	AGO	% of TPC	PMS+AGO	(%)	ATK	% of TPC	FO	% of TPC	AGO	% of TPC	FO+AGO	(%)	AGO	% of TPC	
1980	121.8	63.2	33.4	17.4	155.2	80.6	29.1	15.1	3.2	1.7	5.0	2.6	8.3	4.3			192.6
1981	152.9	63.9	39.3	16.4	192.3	80.4	36.5	15.3	4.5	1.9	5.9	2.5	10.4	4.4			239.2
1982	172.0	64.6	42.0	15.8	213.9	80.4	41.1	15.4	4.8	1.8	6.3	2.4	11.1	4.2			266.1
1983	177.8	64.6	43.3	15.7	221.1	80.3	42.5	15.4	5.1	1.9	6.5	2.4	11.6	4.2			275.2
1984	169.3	65.2	40.4	15.5	209.7	80.7	40.5	15.6	3.5	1.4	6.1	2.3	9.6	3.7			259.8
1985	169.1	66.2	37.1	14.5	206.2	80.7	40.4	15.8	3.2	1.3	5.6	2.2	8.8	3.4			255.4
1986	154.0	72.3	31.8	14.9	185.9	87.2	17.8	8.4	4.6	2.2	4.8	2.2	9.4	4.4			213.1
1987	155.5	72.6	29.6	13.8	185.1	86.5	19.4	9.1	5.1	2.4	4.4	2.1	9.6	4.5			214.1
1988	165.4	74.3	32.7	14.7	198.1	89.0	14.3	6.4	5.4	2.4	4.9	2.2	10.3	4.6			222.7
1989	187.6	76.2	34.4	14.0	222.0	90.2	14.9	6.0	4.2	1.7	5.2	2.1	9.4	3.8			246.2
1990	185.7	57.9	41.0	12.8	226.7	70.6	84.2	26.2	3.8	1.2	6.1	1.9	10.0	3.1			320.9
1991	185.8	73.5	41.0	16.2	226.8	89.7	16.0	6.3	3.8	1.5	6.2	2.4	10.0	3.9			252.8
1992	187.1	75.8	32.1	13.0	219.3	88.9	19.4	7.9	3.3	1.3	4.8	2.0	8.1	3.3			246.8
1993	226.9	72.2	57.9	18.4	284.9	90.6	17.6	5.6	3.4	1.1	8.7	2.8	12.1	3.8			314.5
1994	239.9	78.8	39.7	13.1	279.6	91.9	15.4	5.1	3.3	1.1	6.0	2.0	9.2	3.0			304.3
1995	175.6	72.4	39.0	16.1	214.6	88.5	16.2	6.7	5.8	2.4	5.8	2.4	11.7	4.8			242.5
1996	169.5	71.5	39.0	16.4	208.4	87.9	15.3	6.5	7.5	3.2	5.8	2.5	13.3	5.6			237.1
1997	168.5	67.0	45.6	18.1	214.1	85.1	18.5	7.4	10.0	4.0	6.8	2.7	16.8	6.7	2.0	0.8	251.5
1998	150.1	77.1	31.1	16.0	181.3	93.0	1.2	0.6	6.4	3.3	4.7	2.4	11.1	5.7	1.3	0.7	194.8
1999	134.1	78.1	27.4	15.9	161.5	94.1	1.4	0.8	3.3	1.9	4.1	2.4	7.4	4.3	1.4	0.8	171.7
2000	190.3	80.1	38.3	16.1	228.6	96.2	0.4	0.2	1.0	0.4	5.7	2.4	6.7	2.8	1.8	0.8	237.5

Table 5. Energy Consumption values in the Nigerian transportation sector from 1980-2010 continued

2001	250.8	68.4	46.1	12.6	296.9	81.0	59.9	16.3	0.9	0.3	6.9	1.9	7.9	2.1	1.9	0.5	366.6
2002	275.4	81.6	41.4	12.2	316.8	93.8	12.1	3.6	1.1	0.3	6.2	1.8	7.3	2.2	1.5	0.5	337.7
2003	271.5	80.0	39.4	11.6	310.9	91.6	14.3	4.2	6.7	2.0	5.9	1.7	12.6	3.7	1.5	0.4	339.3
2004	258.3	88.0	24.7	8.4	283.0	96.5	3.2	1.1	2.3	0.8	3.7	1.3	6.0	2.0	1.2	0.4	293.4
2005	307.2	87.6	34.9	10.0	342.2	97.5	0.3	0.1	2.2	0.6	5.2	1.5	7.5	2.1	0.9	0.3	350.9
2006	376.2	90.7	23.4	5.6	399.6	96.3	10.7	2.6	1.0	0.2	3.5	0.8	4.5	1.1			414.9
2007	328.6	92.9	10.8	3.0	339.3	95.9	12.1	3.4	0.6	0.2	1.6	0.5	2.3	0.6			353.7
2008	306.5	82.6	21.9	5.9	328.4	88.5	37.1	10.0	2.1	0.6	3.3	0.9	5.4	1.5			370.9
2009	292.4	87.3	11.2	3.3	303.6	90.6	28.1	8.4	1.6	0.5	1.7	0.5	3.3	1.0			335.0
2010	386.6	91.8	23.0	5.5	409.6	97.2	7.3	1.7	1.0	0.2	3.4	0.8	4.4	1.0			421.3

Source: Badmus *et al*., (2012).

Appendix C**: Linkages in the SAM and CGE model**



Source: Author’s initiative
*ROW means Rest of the World
Note: The arrows represent payment flow across the blocks. With the exception of taxes, transfers and savings, the model also includes “real” flows (i.e volume of factors or commodities) that go in opposite direction.

Appendix D: **Activity Sectors in the modified 2006 Nigeria SAM**

Code name/ Sector description	Subsectors
Food: comprise six major staples	Rice, Wheat, Maize, Sorghum, Millet, and Cassava
Ocrop: other agricultural crops	Yams, Cocoyams, Irish Potato, Sweet Potato, Banana and Plantain, Beans, Groundnuts, Soyabeans, Beniseed, Vegetables, Fruits, Cocoa, Coffee, Cotton, Oil palm, Sugar and Sugar cane, Unprocessed tobacco, Nuts, Cashew, Rubber, Other crops not specified
Live: livestock	Cattle, live goats and sheep, live poultry, and other livestock
Otheragr: other agriculture	Fish and fish meat, and forestry
Man: Manufacturing	Beef, Goat and sheep meat, Poultry meat, Eggs, Milk, Other meat, Beverages, Processed food products, Textiles, Wood, Wood products, furniture, Transportation and other equipment, Other manufacturing
Coil: Crude pretroleum	Crude petroleum
Roil: Refined oil	Refined petroleum
Omin: Other mining	Other mining
Transp: Transport	Road transport, Other transportation
Ser: Services	Building and Construction, Electricity and water, Wholesale and retail trade, Hotel and restaurants, Telecommunications, post, broadcasting, Finance and other business services, Real estate, Education, Health, Other private services
Ntr: Non-tradable	Public Administration

Appendix E 1: **Supplementary Results for Food and Oil Price Shocks Scenario**[104]

A: Value added (VA)

	FOOD				***OCROP***				***LIVE***				***OTHERAGR***			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	4,013,949	3.73	1.15	0.71	4,933,503	-0.42	0.66	0.40	443,072	-1.04	-0.44	-0.25	366,620	-1.00	2.22	1.36
2	4,134,367	3.84	0.48	0.32	5,081,508	-0.38	0.06	0.05	456,364	-0.99	-1.30	-0.83	377,619	-0.93	1.14	0.78
3	4,258,398	3.94	0.19	0.11	5,233,954	-0.34	-0.27	-0.19	470,055	-0.95	-2.19	-1.41	388,947	-0.88	0.79	0.51
4	4,386,150	4.03	-0.09	-0.08	5,390,972	-0.30	-0.60	-0.42	484,157	-0.93	-3.15	-2.04	400,616	-0.83	0.48	0.29
5	4,517,735	4.10	-0.37	-0.28	5,552,701	-0.28	-0.96	-0.65	498,681	-0.91	-4.21	-2.72	412,634	-0.79	0.17	0.08
Av	*4,262,120*	***3.93***	***0.27***	***0.16***	*5,238,528*	***-0.34***	***-0.22***	***-0.16***	*470,466*	***-0.96***	***-2.26***	***-1.45***	*389,287*	***-0.89***	***0.96***	***0.60***

	MAN				***COIL***				***ROIL***				***OMIN***			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	1,639,189	-1.11	0.35	0.23	10,583,727	-0.01	0.03	0.02	89,432	-0.09	3.00	1.99	40,817	-0.31	0.47	0.28
2	1,688,365	-1.05	-0.69	-0.43	10,901,239	-0.05	-1.33	-0.77	92,115	-0.44	38.80	21.92	42,042	-0.38	-1.03	-0.61
3	1,739,016	-1.00	-1.52	-0.98	11,228,276	-0.11	-2.21	-1.36	94,878	-0.64	42.34	25.86	43,303	-0.45	-1.98	-1.25
4	1,791,186	-0.97	-2.40	-1.56	11,565,124	-0.17	-3.17	-1.98	97,725	-0.77	42.96	27.03	44,602	-0.52	-2.97	-1.90
5	1,844,922	-0.95	-3.35	-2.18	11,912,078	-0.23	-4.27	-2.67	100,656	-0.85	42.36	27.10	45,940	-0.60	-4.07	-2.60
Av	*1,740,536*	***-1.02***	***-1.52***	***-0.98***	*11,238,089*	***-0.11***	***-2.19***	***-1.35***	*94,961*	***-0.56***	***33.89***	***20.78***	*43,341*	***-0.45***	***-1.92***	***-1.22***

	TRANSP				***SER***				***NTR***			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	571,787	-1.70	-5.10	-3.18	4,728,765	-0.79	-0.84	-0.51	916,436	-1.47	-0.18	-0.11
2	588,940	-1.66	-4.78	-3.12	4,870,628	-0.76	-0.98	-0.64	943,929	-1.42	-0.39	-0.22
3	606,609	-1.62	-5.06	-3.30	5,016,747	-0.74	-1.31	-0.85	972,247	-1.38	-0.34	-0.20
4	624,807	-1.59	-5.40	-3.53	5,167,250	-0.72	-1.68	-1.09	1,001,414	-1.33	-0.24	-0.15
5	643,551	-1.56	-5.76	-3.78	5,322,267	-0.71	-2.09	-1.35	1,031,457	-1.29	-0.10	-0.08
Av	*607,139*	***-1.63***	***-5.22***	***-3.38***	*5,021,131*	***-0.74***	***-1.38***	***-0.89***	*973,097*	***-1.38***	***-0.25***	***-0.15***

[104] All results presented here are based on the simulations from the CGE model.

B: Total intermediate demand for commodity (DIT)

T	FOOD				OCROP				LIVE				OTHERAGR			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	50,563.65	2.47	0.78	0.48	344,695.98	-0.99	0.35	0.23	414,661.51	-1.11	0.35	0.23	22,105.44	-0.94	0.11	0.07
2	52,080.56	2.56	0.09	0.07	355,036.86	-0.94	-0.59	-0.36	427,101.36	-1.05	-0.70	-0.43	22,768.60	-0.89	-0.57	-0.36
3	53,642.97	2.64	-0.30	-0.21	365,687.97	-0.89	-1.32	-0.85	439,914.40	-1.00	-1.52	-0.98	23,451.66	-0.85	-1.09	-0.71
4	55,252.26	2.72	-0.71	-0.48	376,658.60	-0.86	-2.09	-1.36	453,111.83	-0.97	-2.40	-1.56	24,155.21	-0.81	-1.63	-1.07
5	56,909.83	2.78	-1.14	-0.77	387,958.36	-0.83	-2.93	-1.91	466,705.19	-0.94	-3.36	-2.18	24,879.86	-0.79	-2.22	-1.45
Av	*53,689.85*	***2.63***	***-0.26***	***-0.18***	*366,007.55*	***-0.90***	***-1.32***	***-0.85***	*440,298.86*	***-1.01***	***-1.53***	***-0.98***	*23,472.15*	***-0.86***	***-1.08***	***-0.70***

T	MAN				COIL				ROIL				OMIN			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	1,519,285.41	-0.64	-0.51	-0.31	120,016.42	-0.09	3.00	1.99	907,689.78	-1.09	-1.31	-0.81	115,693.72	-0.83	0.04	0.06
2	1,564,863.98	-0.62	-0.18	-0.17	123,616.92	-0.44	38.80	21.92	934,920.47	-1.06	-0.96	-0.66	119,164.53	-0.85	5.06	2.79
3	1,611,809.90	-0.60	-0.51	-0.35	127,325.42	-0.64	42.34	25.86	962,968.08	-1.04	-1.19	-0.79	122,739.47	-0.85	5.13	3.08
4	1,660,164.19	-0.59	-0.93	-0.61	131,145.19	-0.77	42.96	27.03	991,857.13	-1.02	-1.49	-0.98	126,421.65	-0.85	4.71	2.93
5	1,709,969.12	-0.58	-1.42	-0.92	135,079.54	-0.85	42.36	27.10	1,021,612.84	-1.01	-1.83	-1.20	130,214.30	-0.85	4.06	2.57
Av	*1,613,218.52*	***-0.61***	***-0.71***	***-0.47***	*127,436.70*	***-0.56***	***33.89***	***20.78***	*963,809.66*	***-1.04***	***-1.36***	***-0.89***	*122,846.73*	***-0.85***	***3.80***	***2.29***

T	TRANSP				SER			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	892,362.40	-0.97	-0.24	-0.15	3,231,091.27	-0.63	-0.01	0.00
2	919,133.27	-0.95	-0.43	-0.27	3,328,024.00	-0.58	-0.21	-0.14
3	946,707.27	-0.93	-0.68	-0.43	3,427,864.72	-0.54	-0.43	-0.29
4	975,108.48	-0.91	-0.96	-0.61	3,530,700.67	-0.50	-0.67	-0.45
5	1,004,361.74	-0.91	-1.28	-0.82	3,636,621.69	-0.47	-0.93	-0.62
Av	*947,534.63*	***-0.93***	***-0.72***	***-0.46***	*3,430,860.47*	***-0.54***	***-0.45***	***-0.30***

C: Consumption of commodity *i* by type *h* household (C)

FOOD

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	-2.93	-0.91	-0.57	-1.69	-0.38	-0.24	-2.56	-0.51	-0.32	-2.52	0.63	0.37
2	-2.85	-1.01	-0.66	-1.62	-0.57	-0.37	-2.50	-0.66	-0.43	-2.46	0.11	0.08
3	-2.78	-1.25	-0.82	-1.57	-0.78	-0.52	-2.45	-0.86	-0.57	-2.41	-0.14	-0.10
4	-2.72	-1.52	-1.00	-1.52	-1.01	-0.67	-2.40	-1.08	-0.71	-2.36	-0.40	-0.28
5	-2.67	-1.82	-1.20	-1.47	-1.27	-0.84	-2.36	-1.33	-0.87	-2.32	-0.67	-0.46
Av	***-2.79***	***-1.30***	***-0.85***	***-1.57***	***-0.80***	***-0.53***	***-2.45***	***-0.89***	***-0.58***	***-2.41***	***-0.09***	***-0.08***

OCROP

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	-0.46	-0.53	-0.32	0.31	-0.07	-0.05	-0.47	-0.18	-0.11	-0.38	0.97	0.58
2	-0.41	-0.77	-0.50	0.34	-0.38	-0.25	-0.44	-0.45	-0.29	-0.34	0.33	0.22
3	-0.37	-1.04	-0.69	0.38	-0.62	-0.41	-0.41	-0.69	-0.45	-0.32	0.04	0.01
4	-0.34	-1.34	-0.89	0.41	-0.87	-0.58	-0.39	-0.93	-0.62	-0.30	-0.24	-0.18
5	-0.31	-1.67	-1.11	0.43	-1.15	-0.77	-0.37	-1.20	-0.80	-0.28	-0.54	-0.38
Av	***-0.38***	***-1.07***	***-0.70***	***0.37***	***-0.62***	***-0.41***	***-0.42***	***-0.69***	***-0.45***	***-0.32***	***0.11***	***0.05***

LIVE

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	-0.67	-0.12	-0.08	0.33	0.35	0.21	-0.67	0.25	0.14	-0.55	1.75	1.05
2	-0.62	-0.45	-0.28	0.37	-0.06	-0.03	-0.64	-0.13	-0.07	-0.52	0.89	0.60
3	-0.58	0.04	0.01	0.40	-0.28	-0.18	-0.61	-0.33	-0.21	-0.50	0.62	0.40
4	-0.54	-0.24	-0.18	0.44	-0.49	-0.33	-0.59	-0.52	-0.35	-0.48	0.38	0.23
5	-0.51	-0.54	-0.38	0.46	-0.72	-0.48	-0.57	-0.74	-0.49	-0.46	0.14	0.06
Av	***-0.58***	***-0.26***	***-0.18***	***0.40***	***-0.24***	***-0.16***	***-0.62***	***-0.29***	***-0.20***	***-0.50***	***0.76***	***0.47***

OTHERAGR

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	-0.21	-2.28	-1.41	0.70	-1.37	-0.85	-0.29	-1.59	-0.98	-0.16	-0.18	-0.12
2	-0.18	-2.07	-1.36	0.72	-1.36	-0.88	-0.27	-1.50	-0.98	-0.15	-0.54	-0.34
3	-0.16	-2.31	-1.50	0.74	-1.58	-1.02	-0.26	-1.71	-1.11	-0.14	-0.81	-0.53
4	-0.14	-2.62	-1.69	0.76	-1.84	-1.19	-0.26	-1.96	-1.27	-0.13	-1.10	-0.72
5	-0.13	-2.97	-1.92	0.77	-2.13	-1.38	-0.25	-2.25	-1.45	-0.13	-1.42	-0.92
Av	***-0.16***	***-2.45***	***-1.58***	***0.74***	***-1.66***	***-1.06***	***-0.27***	***-1.80***	***-1.16***	***-0.14***	***-0.81***	***-0.53***

MAN

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	0.34	-7.41	-4.58	2.20	-4.93	-3.05	0.04	-5.53	-3.43	0.35	-2.49	-1.56
2	0.36	-6.34	-4.17	2.23	-4.40	-2.89	0.05	-4.82	-3.17	0.35	-2.73	-1.78
3	0.39	-6.81	-4.43	2.25	-4.84	-3.14	0.05	-5.22	-3.39	0.34	-3.28	-2.13
4	0.40	-7.47	-4.83	2.26	-5.40	-3.50	0.04	-5.76	-3.72	0.33	-3.91	-2.53
5	0.41	-8.26	-5.33	2.27	-6.06	-3.91	0.03	-6.40	-4.12	0.32	-4.62	-2.99
Av	***0.38***	***-7.26***	***-4.67***	***2.24***	***-5.13***	***-3.30***	***0.04***	***-5.55***	***-3.37***	***0.34***	***-3.41***	***-2.20***

ROIL

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	1.75	-62.33	-44.69	3.34	-48.93	-35.07	1.24	-52.35	-37.53	1.57	-51.51	-36.92
2	1.60	-53.21	-38.96	3.22	-41.84	-30.63	1.09	-44.71	-32.73	1.42	-44.18	-32.32
3	1.51	-52.59	-38.03	3.15	-41.39	-29.92	0.99	-44.18	-31.94	1.31	-43.73	-31.60
4	1.44	-52.78	-37.94	3.10	-41.57	-29.88	0.91	-44.33	-31.86	1.23	-43.93	-31.56
5	1.38	-53.35	-38.22	3.05	-42.04	-30.12	0.85	-44.79	-32.08	1.15	-44.44	-31.82
Av	***1.54***	***-54.85***	***-39.57***	***3.17***	***-43.15***	***-31.12***	***1.02***	***-46.07***	***-33.23***	***1.34***	***-45.56***	***-32.84***

TRANSP

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	0.13	-2.94	-1.84	0.49	-2.16	-1.35	0.06	-2.35	-1.47	0.12	-1.80	-1.13
2	0.13	-2.43	-1.61	0.49	-1.81	-1.20	0.06	-1.96	-1.30	0.12	-1.58	-1.04
3	0.13	-2.51	-1.65	0.49	-1.89	-1.24	0.05	-2.02	-1.33	0.11	-1.67	-1.10
4	0.13	-2.65	-1.73	0.49	-2.01	-1.31	0.05	-2.14	-1.40	0.11	-1.81	-1.18
5	0.13	-2.83	-1.84	0.49	-2.15	-1.40	0.04	-2.28	-1.48	0.10	-1.97	-1.28
Av	***0.13***	***-2.67***	***-1.73***	***0.49***	***-2.00***	***-1.30***	***0.05***	***-2.15***	***-1.40***	***0.11***	***-1.77***	***-1.15***

SER

	RP			RNP			UP			UNP		
T	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2	FOOD	OIL1	OIL2
1	-0.21	-1.28	-0.79	0.22	-0.83	-0.51	-0.22	-0.94	-0.58	-0.17	-0.32	-0.20
2	-0.19	-1.13	-0.73	0.23	-0.77	-0.50	-0.21	-0.84	-0.55	-0.16	-0.42	-0.27
3	-0.18	-1.20	-0.78	0.24	-0.84	-0.54	-0.21	-0.91	-0.59	-0.15	-0.52	-0.33
4	-0.17	-1.31	-0.85	0.25	-0.93	-0.60	-0.20	-1.00	-0.64	-0.15	-0.62	-0.40
5	-0.16	-1.44	-0.93	0.26	-1.04	-0.67	-0.20	-1.10	-0.71	-0.14	-0.73	-0.47
Av	***-0.18***	***-1.27***	***-0.82***	***0.24***	***-0.88***	***-0.56***	***-0.21***	***-0.96***	***-0.61***	***-0.15***	***-0.52***	***-0.33***

D: Consumption budget of type *h* households (CTH)

T	RP				RNP				UP				UNP			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	2,629,415	2.51	-7.23	-4.48	3,600,753	2.98	-6.42	-3.97	2,316,001	2.02	-6.62	-4.11	4,241,845	1.59	-4.81	-2.98
2	2,708,298	2.44	-5.56	-3.68	3,708,775	2.92	-4.99	-3.30	2,385,481	1.95	-5.11	-3.38	4,369,100	1.53	-3.83	-2.54
3	2,789,547	2.38	-5.62	-3.66	3,820,039	2.88	-5.09	-3.31	2,457,046	1.89	-5.18	-3.37	4,500,173	1.48	-4.00	-2.60
4	2,873,233	2.32	-5.86	-3.77	3,934,640	2.83	-5.36	-3.45	2,530,757	1.83	-5.42	-3.48	4,635,178	1.43	-4.29	-2.76
5	2,959,430	2.27	-6.20	-3.96	4,052,679	2.79	-5.72	-3.65	2,606,680	1.77	-5.76	-3.67	4,774,234	1.38	-4.67	-2.98
Av	*2,791,985*	***2.38***	***-6.09***	***-3.91***	*3,823,377*	***2.88***	***-5.52***	***-3.54***	*2,459,193*	***1.89***	***-5.62***	***-3.60***	*4,504,106*	***1.48***	***-4.32***	***-2.77***

E: Purchaser price of composite commodity (including all taxes) (PC)

	FOOD [1.06]			OCROP [1.01]			LIVE [1.00]			OTHERAGR [1.09]			MAN [1.01]			COIL [1.00]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	6.81	-5.82	-3.60	1.87	-6.50	-4.03	1.99	-7.26	-4.50	1.32	-4.28	-2.63	0.79	-2.75	-1.68	-0.04	1.47	0.98
2	6.63	-4.12	-2.72	1.77	-4.55	-3.02	1.90	-5.30	-3.52	1.26	-3.02	-2.00	0.00	-1.87	-1.24	-0.17	19.71	11.41
3	6.47	-3.91	-2.52	1.68	-4.28	-2.76	1.82	-5.19	-3.37	1.21	-2.89	-1.87	0.72	-1.79	-1.15	-0.22	22.36	13.91
4	6.32	-3.83	-2.42	1.60	-4.15	-2.62	1.75	-5.26	-3.37	1.17	-2.87	-1.83	0.70	-1.77	-1.12	-0.22	23.86	15.17
5	6.19	-3.81	-2.37	1.53	-4.08	-2.53	1.69	-5.42	-3.43	1.13	-2.89	-1.82	0.67	-1.79	-1.12	-0.20	25.01	16.02
Av	***6.48***	***-4.30***	***-2.73***	***1.69***	***-4.71***	***-2.99***	***1.83***	***-5.69***	***-3.64***	***1.22***	***-3.19***	***-2.03***	***0.58***	***-1.99***	***-1.26***	***-0.17***	***18.48***	***11.50***

	ROIL [0.83]			OMIN [1.08]			TRANSP [1.00]			SER [1.00]			NTR [1.00]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-0.13	55.50	34.37	-0.02	-0.03	-0.01	0.58	2.36	1.46	1.69	-3.40	-2.11	1.49	0.18	0.11
2	-0.05	43.73	28.61	-0.01	0.26	0.15	0.57	2.15	1.40	1.62	-2.35	-1.58	1.44	0.40	0.22
3	0.00	42.53	27.47	-0.01	0.32	0.20	0.55	2.21	1.43	1.56	-2.31	-1.51	1.40	0.34	0.20
4	0.03	42.19	27.07	0.00	0.36	0.23	0.54	2.28	1.48	1.50	-2.38	-1.52	1.35	0.24	0.15
5	0.05	42.19	26.96	0.00	0.40	0.26	0.53	2.35	1.53	1.45	-2.51	-1.58	1.31	0.10	0.08
Av	***-0.02***	***45.23***	***28.90***	***-0.01***	***0.26***	***0.17***	***0.55***	***2.27***	***1.46***	***1.56***	***-2.59***	***-1.66***	***1.40***	***0.25***	***0.15***

Note: Values in parenthesis represent base year purchaser's price of composite commodity, and it is constant over the simulation period

F: Price of local product *i* sold on the domestic market (including all taxes) (PD)

T	FOOD [1.06] S1FOOD	FOOD S2OIL1	FOOD S2OIL2	OCROP [1.01] S1FOOD	OCROP S2OIL1	OCROP S2OIL2	LIVE [1.00] S1FOOD	LIVE S2OIL1	LIVE S2OIL2
1	3.59	-6.59	-4.08	1.94	-6.72	-4.16	1.99	-7.26	-4.50
2	3.40	-4.67	-3.10	1.83	-4.71	-3.12	1.90	-5.30	-3.52
3	3.23	-4.44	-2.86	1.74	-4.42	-2.85	1.82	-5.19	-3.37
4	3.07	-4.34	-2.75	1.65	-4.28	-2.71	1.75	-5.26	-3.37
5	2.93	-4.32	-2.70	1.58	-4.22	-2.62	1.69	-5.42	-3.43
Av	***3.24***	***-4.87***	***-3.10***	***1.75***	***-4.87***	***-3.09***	***1.83***	***-5.69***	***-3.64***

T	OTHERAGR [1.09] S1FOOD	OTHERAGR S2OIL1	OTHERAGR S2OIL2	MAN [1.01] S1FOOD	MAN S2OIL1	MAN S2OIL2	COIL [1.00] S1FOOD	COIL S2OIL1	COIL S2OIL2
1	1.85	-5.86	-3.63	1.62	-5.43	-3.36	-0.04	1.49	0.99
2	1.77	-4.16	-2.77	1.54	-3.74	-2.50	-0.17	19.98	11.56
3	1.70	-3.98	-2.59	1.48	-3.57	-2.32	-0.22	22.68	14.09
4	1.63	-3.95	-2.53	1.42	-3.53	-2.25	-0.22	24.19	15.37
5	1.58	-3.99	-2.52	1.37	-3.57	-2.24	-0.20	25.36	16.23
Av	***1.71***	***-4.39***	***-2.81***	***1.49***	***-3.97***	***-2.53***	***-0.17***	***18.74***	***11.65***

T	ROIL [0.83] S1FOOD	ROIL S2OIL1	ROIL S2OIL2	OMIN [1.08] S1FOOD	OMIN S2OIL1	OMIN S2OIL2	TRANSP [1.00] S1FOOD	TRANSP S2OIL1	TRANSP S2OIL2
1	-0.41	46.45	28.95	-0.15	-0.24	-0.13	1.09	4.48	2.76
2	-0.15	17.48	13.36	-0.12	2.44	1.37	1.06	4.09	2.63
3	0.00	14.96	10.58	-0.08	3.00	1.83	1.03	4.20	2.71
4	0.09	14.25	9.63	-0.04	3.41	2.14	1.01	4.34	2.80
5	0.15	14.25	9.36	0.01	3.81	2.41	0.98	4.47	2.90
Av	***-0.06***	***21.48***	***14.38***	***-0.08***	***2.48***	***1.52***	***1.03***	***4.32***	***2.76***

T	SER [1.00] S1FOOD	SER S2OIL1	SER S2OIL2	NTR [1.00] S1FOOD	NTR S2OIL1	NTR S2OIL2
1	1.84	-3.69	-2.29	1.49	0.18	0.11
2	1.77	-2.55	-1.72	1.44	0.40	0.22
3	1.70	-2.51	-1.64	1.40	0.34	0.20
4	1.64	-2.58	-1.66	1.35	0.24	0.15
5	1.59	-2.73	-1.72	1.31	0.10	0.08
Av	***1.71***	***-2.81***	***-1.81***	***1.40***	***0.25***	***0.15***

G: Price received for exported commodity *x* (excluding export taxes) (PE)

T	OCROP S1FOOD	OCROP S2OIL1	OCROP S2OIL2	OTHERAGR S1FOOD	OTHERAGR S2OIL1	OTHERAGR S2OIL2	MAN S1FOOD	MAN S2OIL1	MAN S2OIL2	COIL S1FOOD	COIL S2OIL1	COIL S2OIL2
1	1.07	-3.56	-2.19	1.17	-3.51	-2.16	1.08	-2.79	-1.72	0.00	0.01	0.01
2	1.00	-2.38	-1.57	1.12	-2.38	-1.58	1.03	-1.68	-1.13	0.02	1.03	0.58
3	0.95	-2.16	-1.38	1.07	-2.20	-1.43	0.98	-1.38	-0.90	0.05	1.53	0.92
4	0.90	-2.01	-1.25	1.02	-2.11	-1.35	0.95	-1.14	-0.72	0.08	2.06	1.26
5	0.85	-1.88	-1.15	0.99	-2.06	-1.29	0.92	-0.91	-0.55	0.11	2.65	1.63
Av	***0.95***	***-2.40***	***-1.51***	***1.07***	***-2.45***	***-1.56***	***0.99***	***-1.58***	***-1.00***	***0.05***	***1.46***	***0.88***

T	OMIN S1FOOD	OMIN S2OIL1	OMIN S2OIL2	TRANSP S1FOOD	TRANSP S2OIL1	TRANSP S2OIL2	SER S1FOOD	SER S2OIL1	SER S2OIL2
1	0.07	-0.23	-0.14	0.96	3.46	2.13	1.11	-1.62	-1.01
2	0.10	1.05	0.60	0.94	3.19	2.05	1.06	-1.01	-0.69
3	0.14	1.56	0.96	0.91	3.32	2.14	1.02	-0.91	-0.59
4	0.18	2.04	1.29	0.89	3.49	2.25	0.99	-0.86	-0.54
5	0.22	2.57	1.63	0.88	3.66	2.37	0.96	-0.82	-0.51
Av	***0.14***	***1.40***	***0.87***	***0.92***	***3.42***	***2.19***	***1.03***	***-1.04***	***-0.67***

Note: Price received for exported commodity was assigned 1 at base year.

H: Price of local product *i* (excluding all taxes on products) (PL)

T	FOOD [1.06]			OCROP [1.01]			LIVE [1.00]			OTHERAGR [1.09]			MAN [1.01]			COIL [1.00]		
	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	3.59	-6.59	-4.08	1.94	-6.72	-4.16	1.99	-7.26	-4.50	1.85	-5.86	-3.63	1.62	-5.43	-3.36	-0.04	1.49	0.99
2	3.40	-4.67	-3.10	1.83	-4.71	-3.12	1.90	-5.30	-3.52	1.77	-4.16	-2.77	1.54	-3.74	-2.50	-0.17	19.98	11.56
3	3.23	-4.44	-2.86	1.74	-4.42	-2.85	1.82	-5.19	-3.37	1.70	-3.98	-2.59	1.48	-3.57	-2.32	-0.22	22.68	14.09
4	3.07	-4.34	-2.75	1.65	-4.28	-2.71	1.75	-5.26	-3.37	1.63	-3.95	-2.53	1.42	-3.53	-2.25	-0.22	24.19	15.37
5	2.93	-4.32	-2.70	1.58	-4.22	-2.62	1.69	-5.42	-3.43	1.58	-3.99	-2.52	1.37	-3.57	-2.24	-0.20	25.36	16.23
Av	***3.24***	***-4.87***	***-3.10***	***1.75***	***-4.87***	***-3.09***	***1.83***	***-5.69***	***-3.64***	***1.71***	***-4.39***	***-2.81***	***1.49***	***-3.97***	***-2.53***	***-0.17***	***18.74***	***11.65***

T	ROIL [0.83]			OMIN [1.08]			TRANSP [1.00]			SER [1.00]			NTR [1.00]		
	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-0.41	46.45	28.95	-0.15	-0.24	-0.13	1.09	4.48	2.76	1.84	-3.69	-2.29	1.49	0.18	0.11
2	-0.15	17.48	13.36	-0.12	2.44	1.37	1.06	4.09	2.63	1.77	-2.55	-1.72	1.44	0.40	0.22
3	0.00	14.96	10.58	-0.08	3.00	1.83	1.03	4.20	2.71	1.70	-2.51	-1.64	1.40	0.34	0.20
4	0.09	14.25	9.63	-0.04	3.41	2.14	1.01	4.34	2.80	1.64	-2.58	-1.66	1.35	0.24	0.15
5	0.15	14.25	9.36	0.01	3.81	2.41	0.98	4.47	2.90	1.59	-2.73	-1.72	1.31	0.10	0.08
Av	***-0.06***	***21.48***	***14.38***	***-0.08***	***2.48***	***1.52***	***1.03***	***4.32***	***2.76***	***1.71***	***-2.81***	***-1.81***	***1.40***	***0.25***	***0.15***

I: Price of imported product *m* (including all taxes and tariffs) (PM)

T	FOOD [1.84]			OCROP [1.09]			LIVE [1.00]			OTHERAGR [1.15]			MAN [1.01]			COIL [1.00]		
	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
t_1 - t_5	2.53 (37)	1.84	1.84	1.09	1.09	1.09	1.00	1.00	1.00	1.15	1.15	1.15	1.01	1.01	1.01	1.00	1.00	1.00

T	ROIL [0.77]			OMIN [1.09]			TRANSP [1.00]			SER [1.00]		
	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
t_1 - t_5	0.77	1.23 (60)	1.06 (37)	1.09	1.09	1.09	1.00	1.00	1.00	1.00	1.00	1.00

Note: (i) The values in parenthesis represent base year price of imported products inclusive of all taxes and tariffs. It is constant over the simulation period; (ii) values in brackets represent%age change from base year value; (iii) t_1-t_5 indicates that the prices are constant over the five-year period.

J: Price Indexes

	PIXCON			PIXGDP			PIXGOV		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	2.70	-3.93	-2.42	1.51	-4.46	-2.77	1.52	-0.42	-0.26
2	2.61	-2.69	-1.79	1.45	-3.05	-2.04	1.47	-0.06	-0.07
3	2.53	-2.54	-1.64	1.39	-2.77	-1.81	1.42	-0.10	-0.08
4	2.46	-2.50	-1.58	1.35	-2.56	-1.65	1.38	-0.19	-0.12
5	2.39	-2.50	-1.55	1.31	-2.38	-1.51	1.33	-0.33	-0.19
Av	***2.54***	***-2.83***	***-1.80***	***1.40***	***-3.04***	***-1.96***	***1.42***	***-0.22***	***-0.14***

Note: Base year values for all price indexes are valued at 1.

K: Price of industry *j* value added (PVA)

	FOOD [0.60]			OCROP [0.57]			LIVE [0.87]			OTHERAGR [0.86]			MAN [0.80]			COIL [0.65]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	3.87	-7.13	-4.42	2.01	-7.27	-4.51	1.97	-7.70	-4.77	1.96	-7.04	-4.36	1.61	-7.42	-4.59	-0.05	-0.50	-0.31
2	3.66	-5.07	-3.36	1.89	-5.10	-3.38	1.88	-5.64	-3.75	1.87	-5.04	-3.35	1.54	-5.15	-3.44	-0.03	1.06	0.55
3	3.47	-4.80	-3.10	1.79	-4.78	-3.08	1.80	-5.52	-3.59	1.79	-4.82	-3.13	1.47	-4.88	-3.17	0.00	1.67	0.98
4	3.30	-4.69	-2.97	1.70	-4.61	-2.91	1.73	-5.59	-3.58	1.73	-4.76	-3.05	1.42	-4.78	-3.06	0.03	2.26	1.37
5	3.14	-4.65	-2.89	1.63	-4.52	-2.80	1.67	-5.76	-3.65	1.67	-4.78	-3.03	1.37	-4.76	-3.00	0.07	2.92	1.78
Av	***3.49***	***-5.27***	***-3.35***	***1.80***	***-5.26***	***-3.34***	***1.81***	***-6.04***	***-3.87***	***1.80***	***-5.29***	***-3.38***	***1.48***	***-5.40***	***-3.45***	***0.00***	***1.48***	***0.87***

	ROIL [0.65]			OMIN [0.67]			TRANSP [0.83]			SER [0.92]			NTR [1.00]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-2.93	205.05	127.68	-0.18	-4.23	-2.61	1.51	-9.63	-6.01	2.13	-7.70	-4.78	2.24	-7.60	-4.71
2	-1.43	33.45	33.96	0.00	-1.07	-0.88	1.45	-6.78	-4.50	2.04	-5.68	-3.77	2.16	-5.81	-3.85
3	-0.60	16.32	15.95	-0.09	-0.30	-0.28	1.40	-6.22	-4.03	1.96	-5.57	-3.62	2.10	-5.83	-3.79
4	-0.14	9.99	8.94	-0.03	0.34	0.17	1.36	-5.87	-3.75	1.89	-5.63	-3.62	2.03	-6.04	-3.89
5	0.12	7.64	5.98	0.03	0.97	0.59	1.33	-5.62	-3.54	1.83	-5.80	-3.69	1.97	-6.36	-4.06
Av	***-1.00***	***54.49***	***38.50***	***-0.05***	***-0.86***	***-0.60***	***1.41***	***-6.82***	***-4.37***	***1.97***	***-6.08***	***-3.90***	***2.10***	***-6.33***	***-4.06***

L: Rental rate of Industry *j* composite capital (RC)

	FOOD			***OCROP***			***LIVE***			***OTHERAGR***			***MAN***			***COIL***		
	[0.37]			[0.37]			[0.65]			[0.65]			[0.65]			[0.65]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	6.45	-6.67	-4.10	1.73	-7.12	-4.39	1.28	-8.25	-5.08	1.29	-5.88	-3.60	0.86	-7.44	-4.57	-0.06	-0.52	-0.32
2	6.02	-3.85	-2.56	1.57	-4.13	-2.76	1.14	-5.07	-3.43	1.17	-3.05	-2.09	0.79	-4.23	-2.88	-0.04	1.19	0.62
3	5.63	-3.17	-2.01	1.42	-3.42	-2.17	1.03	-4.65	-3.02	1.07	-2.27	-1.49	0.73	-3.65	-2.38	-0.01	1.76	1.03
4	5.27	-2.56	-1.54	1.30	-2.79	-1.68	0.94	-4.36	-2.76	0.99	-1.53	-0.98	0.68	-3.18	-2.02	0.02	2.34	1.41
5	4.95	-1.95	-1.08	1.20	-2.17	-1.21	0.85	-4.14	-2.56	0.93	-0.79	-0.47	0.64	-2.76	-1.70	0.06	2.99	1.82
Av	***5.66***	***-3.64***	***-2.26***	***1.44***	***-3.93***	***-2.44***	***1.05***	***-5.29***	***-3.37***	***1.09***	***-2.70***	***-1.73***	***0.74***	***-4.25***	***-2.71***	***-0.01***	***1.55***	***0.91***

	ROIL			***OMIN***			***TRANSP***			***SER***			***NTR***		
	[0.65]			[0.65]			[0.65]			[0.65]			[0.65]		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-3.32	224.53	139.11	-0.58	-3.80	-2.34	0.36	-13.00	-8.16	1.60	-8.49	-5.25	1.24	-7.94	-4.91
2	-1.55	24.62	29.69	-0.51	-0.05	-0.28	0.33	-8.11	-5.43	1.43	-4.88	-3.31	1.20	-5.98	-3.96
3	-0.62	12.05	13.31	-0.42	0.74	0.36	0.31	-6.75	-4.36	1.29	-4.11	-2.67	1.16	-6.03	-3.92
4	-0.13	7.74	7.36	-0.34	1.44	0.86	0.31	-5.55	-3.49	1.17	-3.47	-2.19	1.13	-6.20	-3.99
5	0.14	6.49	5.09	-0.25	2.20	1.34	0.32	-4.39	-2.69	1.07	-2.86	-1.75	1.10	-6.44	-4.12
Av	***-1.10***	***55.09***	***38.91***	***-0.42***	***0.11***	***-0.01***	***0.33***	***-7.56***	***-4.83***	***1.31***	***-4.76***	***-3.03***	***1.17***	***-6.52***	***-4.18***

Note: Values in parenthesis represent base year rental rate of industry composite capital, and it is constant over the simulation period

M: Wage rate* (W)

T	S1FOOD	S2OIL1	S2OIL2
1	2.26	-7.89	-4.87
2	2.26	-5.75	-3.83
3	2.26	-5.83	-3.80
4	2.26	-6.07	-3.90
5	2.26	-6.41	-4.08
Av	***2.26***	***-6.39***	***-4.10***

*Wage rate was exogenously fixed at 1

N: Direct Taxes on Firms and Households

	TDF			TDHT			TDH H-U-P			TDH H-U-NP		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	0.16	-0.59	-0.37	1.64	-5.03	-3.12	2.02	-6.62	-4.11	1.59	-4.81	-2.98
2	0.15	-1.03	-0.67	1.58	-3.99	-2.64	1.95	-5.11	-3.38	1.53	-3.83	-2.54
3	0.13	-1.52	-0.98	1.53	-4.14	-2.69	1.89	-5.18	-3.37	1.48	-4.00	-2.60
4	0.10	-2.05	-1.33	1.48	-4.42	-2.84	1.83	-5.42	-3.48	1.43	-4.29	-2.76
5	0.08	-2.66	-1.71	1.43	-4.80	-3.06	1.77	-5.76	-3.67	1.38	-4.67	-2.98
Av	***0.12***	***-1.57***	***-1.01***	***1.53***	***-4.48***	***-2.87***	***1.89***	***-5.62***	***-3.60***	***1.48***	***-4.32***	***-2.77***

O: Government revenue from indirect taxes on product (TIC)

	FOOD			OCROP			LIVE			OTHERAGR		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	4.23	-6.28	-3.89	1.59	-6.38	-3.95	0.93	-7.67	-4.74	1.36	-5.37	-3.32
2	4.12	-4.77	-3.15	1.53	-4.85	-3.21	0.89	-6.54	-4.33	1.32	-4.20	-2.78
3	4.03	-4.78	-3.10	1.47	-4.87	-3.16	0.86	-7.27	-4.74	1.29	-4.32	-2.81
4	3.95	-4.94	-3.17	1.42	-5.05	-3.23	0.81	-8.24	-5.34	1.26	-4.57	-2.95
5	3.87	-5.19	-3.29	1.37	-5.32	-3.37	0.76	-9.40	-6.06	1.23	-4.91	-3.14
Av	***4.04***	***-5.19***	***-3.32***	***1.48***	***-5.29***	***-3.38***	***0.85***	***-7.82***	***-5.04***	***1.29***	***-4.67***	***-3.00***

P: Government revenue from import duties on product (TIM)

	FOOD			OCROP			OTHERAGR			MAN			ROIL			OMIN		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-18.74	-11.74	-7.34	3.49	-12.47	-7.82	2.69	-9.42	-5.87	2.14	-10.41	-6.49	-0.91	38.06	23.78	-0.87	-0.01	0.03
2	-18.96	-8.69	-5.79	3.32	-9.18	-6.13	2.60	-7.09	-4.73	2.06	-8.11	-5.43	-0.75	19.74	14.36	-0.88	5.61	3.10
3	-19.15	-8.50	-5.54	3.17	-8.94	-5.83	2.52	-7.09	-4.63	1.98	-8.55	-5.61	-0.65	17.57	12.33	-0.87	5.80	3.49
4	-19.33	-8.58	-5.51	3.04	-8.98	-5.77	2.44	-7.31	-4.72	1.90	-9.31	-6.04	-0.59	16.63	11.43	-0.86	5.48	3.40
5	-19.49	-8.80	-5.59	2.91	-9.18	-5.81	2.37	-7.67	-4.91	1.82	-10.29	-6.62	-0.56	16.13	10.95	-0.85	4.90	3.10
Av	***-19.13***	***9.26***	***-5.95***	***3.19***	***-9.75***	***-6.27***	***2.52***	***-7.72***	***-4.97***	***1.98***	***-9.33***	***-6.04***	***-0.69***	***21.63***	***14.57***	***-0.87***	***4.36***	***2.62***

Q: Government revenue from taxes on industry production (TIP)

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*			*MAN*			*COIL*		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	7.46	-5.51	-3.40	1.50	-6.07	-3.76	0.93	-7.67	-4.73	0.83	-3.77	-2.32	0.47	-5.01	-3.08	-0.01	0.06	0.04
2	7.37	-4.22	-2.78	1.44	-4.63	-3.06	0.89	-6.53	-4.33	0.82	-3.06	-2.01	0.46	-4.34	-2.87	-0.03	0.04	0.00
3	7.30	-4.25	-2.76	1.39	-4.66	-3.02	0.86	-7.26	-4.74	0.80	-3.23	-2.09	0.44	-4.96	-3.23	-0.06	-0.31	-0.21
4	7.22	-4.43	-2.84	1.34	-4.84	-3.10	0.81	-8.24	-5.34	0.79	-3.49	-2.25	0.42	-5.77	-3.73	-0.09	-0.76	-0.49
5	7.15	-4.68	-2.97	1.29	-5.11	-3.24	0.76	-9.40	-6.06	0.78	-3.83	-2.45	0.40	-6.72	-4.32	-0.13	-1.31	-0.83
Av	***7.30***	***-462***	***-2.95***	***1.39***	***-5.06***	***-3.24***	***0.85***	***-7.82***	***-5.04***	***0.80***	***-3.48***	***-2.22***	***0.44***	***-5.36***	***-3.45***	***-0.06***	***-0.46***	***-0.30***

	ROIL			***TRANSP***			***SER***		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-0.50	50.84	31.51	-0.66	-1.05	-0.64	1.01	-4.44	-2.75
2	-0.60	63.07	38.21	-0.64	-1.06	-0.68	0.97	-3.46	-2.32
3	-0.65	63.64	39.17	-0.63	-1.24	-0.80	0.93	-3.74	-2.45
4	-0.68	63.33	39.26	-0.62	-1.46	-0.94	0.89	-4.16	-2.69
5	-0.70	62.64	38.99	-0.61	-1.71	-1.10	0.85	-4.70	-3.01
Av	***-0.63***	***60.70***	***37.43***	***-0.63***	***-1.30***	***-0.83***	***0.93***	***-4.10***	***-2.64***

R: Aggregate Indirect Taxes

	TICT			TIMT			TIPT			TPRCTS			TPRODN		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	1.47	-5.65	-3.49	-13.38	-11.05	-6.91	0.59	-2.62	-1.62	-10.80	-10.11	-6.31	0.59	-2.62	-1.62
2	1.43	-4.41	-2.92	-13.56	-8.03	-5.38	0.56	-1.61	-1.16	-10.95	-7.40	-4.95	0.56	-1.61	-1.16
3	1.39	-4.54	-2.95	-13.72	-7.93	-5.19	0.53	-1.92	-1.31	-11.10	-7.34	-4.80	0.53	-1.92	-1.31
4	1.35	-4.81	-3.09	-13.87	-8.12	-5.23	0.50	-2.39	-1.58	-11.23	-7.54	-4.86	0.50	-2.39	-1.58
5	1.31	-5.17	-3.30	-14.01	-8.46	-5.39	0.47	-2.97	-1.93	-11.35	-7.89	-5.02	0.47	-2.97	-1.93
Av	***1.39***	***-4.92***	***-3.15***	***-13.71***	***-8.72***	***-5.62***	***0.53***	***-2.30***	***-1.52***	***-11.09***	***-8.06***	***-5.19***	***0.53***	***-2.30***	***-1.52***

S: Transfers from agent ROW to agent HH

	RP			RNP			UP			UNP		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	2.70	-3.93	-2.42	2.70	-3.93	-2.42	2.70	-3.93	-2.42	2.70	-3.93	-2.42
2	2.61	-2.69	-1.79	2.61	-2.69	-1.79	2.61	-2.69	-1.79	2.61	-2.69	-1.79
3	2.53	-2.54	-1.64	2.53	-2.54	-1.64	2.53	-2.54	-1.64	2.53	-2.54	-1.64
4	2.46	-2.50	-1.58	2.46	-2.50	-1.58	2.46	-2.50	-1.58	2.46	-2.50	-1.58
5	2.39	-2.50	-1.55	2.39	-2.50	-1.55	2.39	-2.50	-1.55	2.39	-2.50	-1.55
Av	***2.54***	***-2.83***	***-1.80***	***2.54***	***-2.83***	***-1.80***	***2.54***	***-2.83***	***-1.80***	***2.54***	***-2.83***	***-1.80***

Note: These%age changes apply also to government transfer to households as well as ROW transfer to government

T: Savings of Government and Households

	GOV			RP			RNP			UP			UNP		
T	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2	S1FOOD	S2OIL1	S2OIL2
1	-1.08	-8.20	-5.11	2.51	-7.23	-4.48	2.98	-6.42	-3.97	2.02	-6.62	-4.11	1.59	-4.81	-2.98
2	-1.18	-6.90	-4.68	2.44	-5.56	-3.68	2.92	-4.99	-3.30	1.95	-5.11	-3.38	1.53	-3.83	-2.54
3	-1.28	-8.11	-5.38	2.38	-5.62	-3.66	2.88	-5.09	-3.31	1.89	-5.18	-3.37	1.48	-4.00	-2.60
4	-1.39	-9.67	-6.33	2.32	-5.86	-3.77	2.83	-5.36	-3.45	1.83	-5.42	-3.48	1.43	-4.29	-2.76
5	-1.50	-11.54	-7.47	2.27	-6.20	-3.96	2.79	-5.72	-3.65	1.77	-5.76	-3.67	1.38	-4.67	-2.98
Av	***-1.29***	***-8.88***	***-5.79***	***2.38***	***-6.09***	***-3.91***	***2.88***	***-5.52***	***-3.54***	***1.89***	***-5.62***	***-3.60***	***1.48***	***-4.32***	***-2.77***

U: Subsidy on Refined Oil

	SUB	
T	S1FOOD	S2OIL1
1	-0.91	-1.14
2	-0.75	-0.94
3	-0.65	-0.82
4	-0.59	-0.75
5	-0.56	-0.70

V: Quantity demanded of composite commodity (Q)

	FOOD				*OCROP*				*LIVE*				*OTHERAGR*			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	3,037,383.13	-2.42	-0.49	-0.30	3,394,085.95	-0.27	0.13	0.08	440,741.86	-1.04	-0.44	-0.25	574,786.40	0.04	-1.14	-0.71
2	3,128,504.63	-2.35	-0.68	-0.44	3,495,908.53	-0.24	-0.31	-0.20	453,964.12	-0.99	-1.31	-0.83	592,029.99	0.06	-1.22	-0.80
3	3,222,359.77	-2.29	-0.90	-0.60	3,600,785.78	-0.20	-0.62	-0.41	467,583.04	-0.95	-2.19	-1.42	609,790.89	0.08	-1.47	-0.95
4	3,319,030.56	-2.24	-1.15	-0.76	3,708,809.36	-0.18	-0.94	-0.63	481,610.53	-0.93	-3.15	-2.04	628,084.62	0.09	-1.76	-1.14
5	3,418,601.48	-2.19	-1.43	-0.95	3,820,073.64	-0.16	-1.29	-0.86	496,058.85	-0.91	-4.21	-2.72	646,927.15	0.10	-2.08	-1.34
Av	*3,225,175.91*	***-2.30***	***-0.93***	***-0.61***	*3,603,932.65*	***-0.21***	***-0.61***	***-0.40***	*467,991.68*	***-0.96***	***-2.26***	***-1.45***	*610,323.81*	***0.07***	***-1.53***	***-0.99***

	MAN				***COIL***				***ROIL***				***OMIN***			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	5,333,669.42	0.55	-5.28	-3.26	120,016.42	-0.09	3.00	1.99	1,059,559.02	-0.65	-8.64	-6.08	115,693.72	-0.83	0.04	0.06
2	5,493,679.50	0.54	-4.56	-3.03	123,616.92	-0.44	38.80	21.92	1,091,345.79	-0.65	-7.26	-5.28	119,164.53	-0.85	5.06	2.79
3	5,658,489.89	0.52	-5.20	-3.39	127,325.42	-0.64	42.34	25.86	1,124,086.17	-0.65	-7.40	-5.30	122,739.47	-0.85	5.13	3.08
4	5,828,244.58	0.50	-6.02	-3.90	131,145.19	-0.77	42.96	27.03	1,157,808.75	-0.65	-7.71	-5.46	126,421.65	-0.85	4.71	2.93
5	6,003,091.92	0.47	-7.00	-4.50	135,079.54	-0.85	42.36	27.10	1,192,543.01	-0.65	-8.10	-5.70	130,214.30	-0.85	4.06	2.57
Av	*5,663,435.06*	***0.52***	***-5.61***	***-3.62***	*127,436.70*	***-0.56***	***33.89***	***20.78***	*1,125,068.55*	***-0.65***	***-7.82***	***-5.56***	*122,846.73*	***-0.85***	***3.80***	***2.29***

	TRANSP				***SER***				***NTR***			
T	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2	BAU N' Million	S1FOOD	S2OIL1	S2OIL2
1	1,215,259.45	-0.66	-0.72	-0.44	6,455,140.17	-0.45	-1.57	-0.96	3,108,960.07	-1.47	-0.18	-0.11
2	1,251,717.23	-0.64	-0.78	-0.50	6,648,794.38	-0.44	-1.49	-0.99	3,202,228.87	-1.42	-0.39	-0.22
3	1,289,268.75	-0.63	-0.98	-0.64	6,848,258.21	-0.42	-1.81	-1.18	3,298,295.74	-1.38	-0.34	-0.20
4	1,327,946.81	-0.62	-1.22	-0.79	7,053,705.95	-0.41	-2.20	-1.43	3,397,244.61	-1.33	-0.24	-0.15
5	1,367,785.21	-0.62	-1.50	-0.97	7,265,317.13	-0.41	-2.64	-1.71	3,499,161.95	-1.29	-0.10	-0.08
Av	*1,290,395.49*	***-0.63***	***-1.04***	***-0.67***	*6,854,243.17*	***-0.43***	***-1.94***	***-1.25***	*3,301,178.25*	***-1.38***	***-0.25***	***-0.15***

Appendix E2: **Supplementary Results for Combined Scenario**

A: **Value added (VA)**

	FOOD		*OCROP*		*LIVE*		*OTHERAGR*	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	4,013,949	4.70	4,933,503	0.23	443,072	-1.42	366,620	1.20
2	4,134,367	4.15	5,081,508	-0.33	456,364	-2.22	377,619	0.18
3	4,258,398	3.94	5,233,954	-0.62	470,055	-3.02	388,947	-0.12
4	4,386,150	3.73	5,390,972	-0.91	484,157	-3.90	400,616	-0.39
5	4,517,735	3.50	5,552,701	-1.23	498,681	-4.89	412,634	-0.66
Av	***4,262,120***	***4.01***	***5,238,528***	***-0.57***	***470,466***	***-3.09***	***389,287***	***0.04***
	MAN		***COIL***		***ROIL***		***OMIN***	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	1,639,189	-0.73	10,583,727	0.02	89,432	2.87	40,817	0.14
2	1,688,365	-1.70	10,901,239	-1.29	92,115	37.91	42,042	-1.33
3	1,739,016	-2.45	11,228,276	-2.16	94,878	41.38	43,303	-2.29
4	1,791,186	-3.25	11,565,124	-3.10	97,725	42.01	44,602	-3.28
5	1,844,922	-4.13	11,912,078	-4.17	100,656	41.46	45,940	-4.37
Av	*1,740,536*	***-2.45***	*11,238,089*	***-2.14***	*94,961*	***33.13***	*43,341*	***-2.23***
	TRANSP		***SER***		***NTR***			
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM		
1	571,787	-6.64	4,728,765	-1.58	916,436	-1.60		
2	588,940	-6.32	4,870,628	-1.70	943,929	-1.81		
3	606,609	-6.58	5,016,747	-1.99	972,247	-1.74		
4	624,807	-6.89	5,167,250	-2.32	1,001,414	-1.63		
5	643,551	-7.23	5,322,267	-2.70	1,031,457	-1.48		
Av	*607,139*	***-6.73***	*5,021,132*	***-2.06***	*973,096*	***-1.65***		

B: **Total intermediate demand for commodity (DIT)**

	FOOD		*OCROP*		*LIVE*		*OTHERAGR*	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	50,563.65	3.13	344,695.98	-0.62	414,661.51	-0.73	22,105.44	-0.80
2	52,080.56	2.55	355,036.86	-1.49	427,101.36	-1.70	22,768.60	-1.43
3	53,642.97	2.22	365,687.97	-2.15	439,914.40	-2.45	23,451.66	-1.90
4	55,252.26	1.89	376,658.60	-2.85	453,111.83	-3.25	24,155.21	-2.39
5	56,909.83	1.52	387,958.36	-3.62	466,705.19	-4.13	24,879.86	-2.92
Av	53,689.86	***2.26***	366,007.55	***-2.14***	440,298.86	***-2.45***	23,472.15	***-1.89***
	MAN		***COIL***		***ROIL***		***OMIN***	
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM	BAU N' Million	S3SIM
1	1,519,285.41	-1.11	120,016.42	2.87	907,689.78	-2.33	115,693.72	-0.75
2	1,564,863.98	-0.77	123,616.92	37.91	934,920.47	-1.98	119,164.53	4.18
3	1,611,809.90	-1.07	127,325.42	41.38	962,968.08	-2.18	122,739.47	4.28
4	1,660,164.19	-1.45	131,145.19	42.01	991,857.13	-2.45	126,421.65	3.91
5	1,709,969.12	-1.91	135,079.54	41.46	1,021,612.84	-2.77	130,214.30	3.31
Av	1,613,218.52	***-1.26***	127,436.70	***33.13***	963,809.66	***-2.34***	122,846.73	***2.99***
	TRANSP		***SER***					
T	BAU N' Million	S3SIM	BAU N' Million	S3SIM				
1	892,362.40	-1.17	3,231,091.27	-0.62				
2	919,133.27	-1.34	3,328,024.00	-0.79				
3	946,707.27	-1.57	3,427,864.72	-0.98				
4	975,108.48	-1.83	3,530,700.67	-1.18				
5	1,004,361.74	-2.12	3,636,621.69	-1.41				
Av	947,534.63	***-1.61***	3,430,860.47	***-1.00***				

C: Consumption of commodity *i* by type *h* household

	FOOD				OCROP				LIVE				OTHERAGR			
T	RP	RNP	UP	UNP	RP	RNP	UP	UNP	RP	RNP	UP	UNP	RP	RNP	UP	UNP
1	-3.63	-1.96	-2.91	-1.83	-0.95	0.21	-0.63	0.56	-0.76	0.65	-0.42	1.13	-2.44	-0.71	-1.84	-0.36
2	-3.71	-2.13	-3.05	-2.30	-1.17	-0.06	-0.88	-0.04	-1.06	0.28	-0.76	0.33	-2.22	-0.66	-1.75	-0.69
3	-3.89	-2.29	-3.20	-2.50	-1.40	-0.27	-1.09	-0.30	-1.26	0.09	-0.94	0.09	-2.43	-0.86	-1.93	-0.94
4	-4.10	-2.46	-3.37	-2.70	-1.67	-0.50	-1.31	-0.56	-1.47	-0.09	-1.11	-0.12	-2.70	-1.09	-2.16	-1.21
5	-4.34	-2.67	-3.57	-2.92	-1.96	-0.74	-1.55	-0.82	-1.71	-0.30	-1.30	-0.34	-3.03	-1.37	-2.42	-1.51
Av	***-3.93***	***-2.30***	***-3.22***	***-2.45***	***-1.43***	***-0.27***	***-1.09***	***-0.23***	***-1.25***	***0.13***	***-0.91***	***0.22***	***-2.56***	***-0.94***	***-2.02***	***-0.94***
	MAN				ROIL				TRANSP				SER			
1	-6.96	-2.83	-5.40	-2.18	-61.12	-46.86	-51.48	-50.48	-2.77	-1.69	-2.25	-1.66	-1.44	-0.61	-1.13	-0.48
2	-5.89	-2.25	-4.70	-2.38	-52.05	-39.68	-43.90	-43.19	-2.27	-1.33	-1.87	-1.44	-1.29	-0.54	-1.03	-0.57
3	-6.31	-2.64	-5.07	-2.90	-51.43	-39.21	-43.38	-42.74	-2.34	-1.41	-1.93	-1.54	-1.35	-0.60	-1.09	-0.66
4	-6.92	-3.17	-5.57	-3.49	-51.60	-39.37	-43.52	-42.93	-2.48	-1.52	-2.04	-1.66	-1.45	-0.68	-1.17	-0.76
5	-7.67	-3.79	-6.18	-4.17	-52.14	-39.82	-43.96	-43.42	-2.65	-1.66	-2.18	-1.82	-1.56	-0.78	-1.26	-0.86
Av	***-6.75***	***-2.94***	***-5.38***	***-3.02***	***-53.67***	***-40.99***	***-45.25***	***-44.55***	***-2.50***	***-1.52***	***-2.05***	***-1.62***	***-1.42***	***-0.64***	***-1.14***	***-0.67***

D: Purchaser price of composite commodity (including all taxes) (PC)

	FOOD [1.06]	OCROP [1.01]	LIVE [1.00]	OTHERAGR [1.09]	MAN [1.01]	COIL [1.00]	ROIL [0.83]	OMIN [1.08]	TRANSP [1.00]	SER [1.00]	NTR [1.00]
1	0.41	-4.66	-5.30	-2.93	-1.92	1.42	55.25	-0.04	2.90	-1.74	1.63
2	2.18	-2.76	-3.38	-1.72	-1.08	19.28	43.69	0.25	2.70	-0.71	1.84
3	2.31	-2.53	-3.31	-1.62	-1.01	21.88	42.51	0.31	2.75	-0.70	1.77
4	2.32	-2.44	-3.40	-1.61	-1.00	23.34	42.17	0.35	2.82	-0.79	1.65
5	2.27	-2.40	-3.58	-1.66	-1.03	24.47	42.17	0.39	2.89	-0.93	1.51

Note: Values in parenthesis represent base year purchaser's price of composite commodity, and it is constant over the simulation period

E: Price of local product *i* sold on the domestic market (including all taxes) (PD)

	FOOD [1.00]	OCROP [1.00]	LIVE [1.00]	OTHERAGR [1.07]	MAN [1.00]	COIL [1.00]	ROIL [1.00]	OMIN [1.00]	TRANSP [1.00]	SER [1.00]	NTR [1.00]
1	-3.23	-4.81	-5.30	-4.04	-3.82	1.44	45.75	-0.36	5.54	-1.89	1.63
2	-1.35	-2.85	-3.38	-2.38	-2.17	19.54	17.39	2.29	5.16	-0.77	1.84
3	-1.21	-2.62	-3.31	-2.24	-2.03	22.18	14.92	2.86	5.26	-0.76	1.77
4	-1.20	-2.52	-3.40	-2.23	-2.01	23.67	14.22	3.30	5.39	-0.86	1.65
5	-1.26	-2.48	-3.58	-2.29	-2.07	24.81	14.21	3.70	5.51	-1.01	1.51

F: Price received for exported commodity (excluding export taxes) (PE)

	OCROP	OTHERAGR	MAN	COIL	OMIN	TRANSP	SER
1	-2.48	-2.33	-1.71	0.01	-0.15	4.40	-0.53
2	-1.35	-1.24	-0.64	1.00	1.12	4.13	0.05
3	-1.16	-1.10	-0.37	1.50	1.64	4.25	0.13
4	-1.03	-1.03	-0.16	2.01	2.13	4.41	0.17
5	-0.93	-0.99	0.04	2.58	2.66	4.57	0.19

Note: Price received for exported commodity was assigned 1 at base year.

G: Price of local product *i* (excluding all taxes on products) (PL)

	FOOD	OCROP	LIVE	OTHERAGR	MAN	COIL	ROIL	OMIN	TRANSP	SER	NTR
1	-3.23	-4.81	-5.30	-4.04	-3.82	1.44	45.75	-0.36	5.54	-1.89	1.63
2	-1.35	-2.85	-3.38	-2.38	-2.17	19.54	17.39	2.29	5.16	-0.77	1.84
3	-1.21	-2.62	-3.31	-2.24	-2.03	22.18	14.92	2.86	5.26	-0.76	1.77
4	-1.20	-2.52	-3.40	-2.23	-2.01	23.67	14.22	3.30	5.39	-0.86	1.65
5	-1.26	-2.48	-3.58	-2.29	-2.07	24.81	14.21	3.70	5.51	-1.01	1.51

H: Price Indexes

	PIXCON	PIXGDP	PIXGOV
1	-1.37	-3.01	1.07
2	-0.13	-1.63	1.42
3	-0.03	-1.37	1.36
4	-0.02	-1.20	1.25
5	-0.06	-1.04	1.10

Note: Base year values for all price indexes are valued at 1.

I: Price of imported product (including all taxes and tariffs) (PM)

	FOOD [1.84]	OCROP [1.09]	LIVE [1.00]	OTHERAGR [1.15]	MAN [1.01]	COIL [1.00]	ROIL [0.77]	OMIN [1.09]	TRANSP [1.00]	SER [1.00]
t_1-t_5	1.84 (37)	1.09	1.00	1.15	1.01	1.00	1.23 (60)	1.09	1.00	1.00

Note: (i) The values in parenthesis represent base year price of imported products inclusive of all taxes and tariffs. It is constant over the simulation period; (ii) values in brackets represent%age change from base year value; (iii) t_1-t_5 indicates that the prices are constant over the five-year period.

J: Basic Price of industry output (PT)

	FOOD	OCROP	LIVE	OTHERAGR	MAN	COIL	ROIL	OMIN	TRANSP	SER	NTR
1	-3.23	-4.79	-5.30	-4.04	-3.75	0.04	45.75	-0.23	5.30	-1.85	1.63
2	-1.35	-2.84	-3.38	-2.38	-2.12	1.35	17.39	1.57	4.94	-0.75	1.84
3	-1.21	-2.60	-3.31	-2.24	-1.97	1.89	14.92	2.11	5.05	-0.73	1.77
4	-1.20	-2.50	-3.40	-2.23	-1.95	2.43	14.22	2.58	5.19	-0.82	1.65
5	-1.26	-2.47	-3.58	-2.29	-2.00	3.02	14.21	3.06	5.32	-0.98	1.51

K: Price of industry value added (PVA)

	FOOD [0.60]	OCROP [0.57]	LIVE [0.87]	OTHERAGR [0.86]	MAN [0.80]	COIL [0.65]	ROIL [0.65]	OMIN [0.67]	TRANSP [0.83]	SER [0.92]	NTR [1.00]
1	-3.52	-5.30	-5.76	-5.11	-5.80	-0.55	200.82	-4.38	-8.15	-5.61	-5.42
2	-1.50	-3.19	-3.74	-3.16	-3.58	0.97	32.82	-1.26	-5.34	-3.63	-3.65
3	-1.34	-2.92	-3.66	-2.98	-3.34	1.56	16.06	-0.47	-4.80	-3.55	-3.70
4	-1.32	-2.79	-3.75	-2.95	-3.26	2.15	9.84	0.18	-4.46	-3.64	-3.92
5	-1.36	-2.73	-3.93	-2.99	-3.26	2.79	7.51	0.82	-4.21	-3.83	-4.25

L: Direct Taxes on Firms and Households

	TDF	TDHT	TDH H-U-P	TDH H-U-NP
1	-0.43	-3.43	-4.65	-3.27
2	-0.85	-2.40	-3.16	-2.30
3	-1.32	-2.57	-3.25	-2.47
4	-1.83	-2.86	-3.50	-2.77
5	-2.42	-3.23	-3.84	-3.15

M: Government revenue from indirect taxes on product (TIC)

	FOOD	OCROP	LIVE	OTHERAGR
1	-2.35	-4.80	-6.65	-4.00
2	-0.81	-3.29	-5.53	-2.86
3	-0.85	-3.33	-6.23	-2.98
4	-1.04	-3.52	-7.17	-3.23
5	-1.32	-3.79	-8.29	-3.57

N: Government revenue from import duties on product (TIM)

	FOOD	OCROP	OTHERAGR	MAN	ROIL	OMIN
1	-28.43	-9.23	-6.82	-8.30	36.59	-0.83
2	-26.02	-5.96	-4.52	-6.01	18.78	4.69
3	-25.95	-5.78	-4.55	-6.47	16.69	4.92
4	-26.09	-5.87	-4.79	-7.22	15.79	4.65
5	-26.33	-6.10	-5.16	-8.18	15.32	4.13

O: Government revenue from taxes on industry production (TIP)

	FOOD	OCROP	LIVE	OTHERAGR	MAN	COIL	ROIL	TRANSP	SER
1	1.32	-4.57	-6.64	-2.89	-4.45	0.06	49.94	-1.69	-3.39
2	2.74	-3.15	-5.53	-2.20	-3.78	0.04	61.89	-1.69	-2.43
3	2.68	-3.20	-6.23	-2.36	-4.38	-0.31	62.47	-1.86	-2.71
4	2.49	-3.39	-7.17	-2.61	-5.14	-0.75	62.20	-2.06	-3.13
5	2.20	-3.67	-8.29	-2.94	-6.04	-1.28	61.56	-2.29	-3.65

P: Aggregate Indirect Taxes

	TICT	TIMT	TIPT	TPRCTS	TPRODN
1	-4.18	-22.92	-1.99	-19.66	-1.99
2	-2.97	-20.38	-1.00	-17.35	-1.00
3	-3.10	-20.38	-1.30	-17.37	-1.30
4	-3.36	-20.61	-1.75	-17.61	-1.75
5	-3.72	-20.97	-2.31	-17.97	-2.31

Q: Transfers from agent ROW to agent HH

	H-R-P	H-R-NP	H-U-P	H-U-NP
1	-1.37	-1.37	-1.37	-1.37
2	-0.13	-0.13	-0.13	-0.13
3	-0.03	-0.03	-0.03	-0.03
4	-0.02	-0.02	-0.02	-0.02
5	-0.06	-0.06	-0.06	-0.06

Note: These%age changes apply also to government transfer to households as well as ROW transfer to government

R: Savings of Government and Households

	GOV	H-R-P	H-R-NP	H-U-P	H-U-NP
1	-9.00	-4.82	-3.60	-4.65	-3.27
2	-7.78	-3.16	-2.15	-3.16	-2.30
3	-8.97	-3.24	-2.27	-3.25	-2.47
4	-10.49	-3.48	-2.54	-3.50	-2.77
5	-12.30	-3.83	-2.90	-3.84	-3.15

S: Subsidy on Refined Oil

	SUB
1	36.59
2	18.78
3	16.69
4	15.79
5	15.32

Appendix E3: **Supplementary Results for Fiscal Policy Response**

A: **Value added (VA)**

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	0.84	2.05	2.01	-0.01	0.74	0.70	-0.64	0.99	0.20	0.13	2.31	2.31
2	0.76	1.05	1.15	-0.12	0.01	0.02	-0.99	0.37	-0.33	0.04	0.50	0.80
3	0.66	1.06	1.04	-0.25	0.00	-0.11	-1.39	0.36	-0.54	-0.06	0.50	0.64
4	0.55	1.07	0.93	-0.40	0.00	-0.24	-1.84	0.38	-0.70	-0.17	0.49	0.47
5	0.42	1.08	0.83	-0.57	0.00	-0.35	-2.35	0.41	-0.79	-0.30	0.46	0.31
Av	***0.65***	***1.26***	***1.19***	***-0.27***	***0.15***	***0.00***	***-1.44***	***0.50***	***-0.43***	***-0.07***	***0.85***	***0.91***
	MAN			***COIL***			***ROIL***			***OMIN***		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	-0.37	1.09	0.67	0.00	0.04	0.04	0.00	4.61	4.01	0.05	0.28	0.37
2	-0.68	0.21	-0.21	-0.42	-0.66	-1.03	-0.43	106.26	74.25	-0.34	-0.73	-0.96
3	-1.03	0.17	-0.48	-0.89	-0.30	-1.14	-0.89	96.62	72.44	-0.77	-0.62	-1.31
4	-1.43	0.15	-0.72	-1.44	0.06	-1.20	-1.38	89.36	73.36	-1.26	-0.53	-1.62
5	-1.89	0.14	-0.89	-2.05	0.42	-1.19	-1.94	85.26	75.66	-1.82	-0.46	-1.87
Av	***-1.08***	***0.35***	***-0.33***	***-0.96***	***-0.09***	***-0.90***	***-0.93***	***76.42***	***59.94***	***-0.83***	***-0.41***	***-1.08***
	TRANSP			***SER***			***NTR***					
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb			
1	0.29	-11.48	-8.94	-0.41	-0.56	-0.80	0.33	-3.15	-1.90			
2	0.20	-8.31	-7.78	-0.54	-0.33	-0.67	0.40	-2.95	-2.26			
3	0.10	-8.94	-8.72	-0.70	-0.37	-0.78	0.47	-3.15	-2.59			
4	-0.02	-9.45	-9.54	-0.87	-0.40	-0.86	0.55	-3.32	-2.91			
5	-0.14	-9.83	-10.28	-1.07	-0.42	-0.91	0.65	-3.46	-3.23			
Av	***0.09***	***-9.60***	***-9.05***	***-0.72***	***-0.42***	***-0.80***	***0.48***	***-3.21***	***-2.58***			

B: **Total intermediate demand for commodity (DIT)**

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	0.49	1.65	1.49	-0.31	0.97	0.61	-0.37	1.09	0.67	-0.20	0.12	0.04
2	0.36	0.79	0.74	-0.59	0.15	-0.19	-0.68	0.21	-0.21	-0.39	-0.39	-0.55
3	0.21	0.79	0.61	-0.90	0.12	-0.44	-1.03	0.17	-0.48	-0.60	-0.46	-0.78
4	0.03	0.80	0.48	-1.25	0.10	-0.65	-1.43	0.15	-0.72	-0.84	-0.50	-0.99
5	-0.17	0.80	0.38	-1.65	0.10	-0.81	-1.89	0.14	-0.89	-1.12	-0.54	-1.15
Av	***0.18***	***0.97***	***0.74***	***-0.94***	***0.29***	***-0.30***	***-1.08***	***0.35***	***-0.33***	***-0.63***	***-0.35***	***-0.69***
	MAN			***COIL***			***ROIL***			***OMIN***		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	-0.02	-1.40	-1.07	0.00	4.61	4.01	-0.01	-3.26	-2.52	-0.29	0.43	0.18
2	-0.19	1.00	0.24	-0.43	106.26	74.25	-0.12	-0.95	-1.34	-0.54	15.85	10.67
3	-0.39	0.74	-0.05	-0.89	96.62	72.44	-0.25	-1.26	-1.72	-0.82	14.32	10.21
4	-0.61	0.55	-0.24	-1.38	89.36	73.36	-0.39	-1.51	-2.01	-1.13	13.17	10.19
5	-0.86	0.45	-0.36	-1.94	85.26	75.66	-0.55	-1.67	-2.23	-1.49	12.52	10.42
Av	***-0.41***	***0.27***	***-0.30***	***-0.93***	***76.42***	***59.94***	***-0.26***	***-1.73***	***-1.96***	***-0.85***	***11.26***	***8.33***

	TRANSP			***SER***		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	0.06	-1.62	-1.07	0.07	-0.95	-0.57
2	-0.05	-0.81	-0.91	0.00	-0.52	-0.56
3	-0.18	-0.92	-1.15	-0.09	-0.67	-0.80
4	-0.32	-1.00	-1.35	-0.19	-0.79	-1.00
5	-0.47	-1.03	-1.51	-0.30	-0.88	-1.18
Av	***-0.19***	***-1.08***	***-1.20***	***-0.10***	***-0.76***	***-0.82***

C: Consumption of commodity *i* by type *h* household (C) **SIM1, SIM2 and SIM3 represent S4FOOD, S4OILa and S4OILb respectively**

	FOOD												OCROP											
	RP			RNP			UP			UNP			RP			RNP			UP			UNP		
T	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	-0.66	-1.74	-1.65	-0.35	-0.88	-0.81	-0.53	-1.19	-1.11	-0.41	0.27	0.25	-0.13	-0.83	-0.76	0.07	-0.15	-0.09	-0.09	-0.41	-0.35	0.05	1.09	1.06
2	-0.75	-1.38	-1.53	-0.43	-0.82	-0.89	-0.61	-1.06	-1.14	-0.49	-0.41	-0.35	-0.24	-0.74	-0.85	-0.02	-0.31	-0.35	-0.18	-0.52	-0.56	-0.05	0.16	0.25
3	-0.86	-1.42	-1.66	-0.52	-0.85	-1.00	-0.70	-1.07	-1.24	-0.59	-0.37	-0.43	-0.37	-0.78	-1.00	-0.12	-0.34	-0.47	-0.28	-0.54	-0.68	-0.16	0.19	0.15
4	-0.99	-1.43	-1.76	-0.63	-0.86	-1.09	-0.81	-1.08	-1.32	-0.70	-0.33	-0.51	-0.51	-0.81	-1.12	-0.24	-0.36	-0.58	-0.40	-0.55	-0.78	-0.28	0.22	0.05
5	-1.14	-1.43	-1.83	-0.75	-0.86	-1.16	-0.93	-1.07	-1.38	-0.83	-0.31	-0.58	-0.68	-0.81	-1.22	-0.38	-0.36	-0.67	-0.53	-0.55	-0.86	-0.43	0.24	-0.03
Av	***-0.88***	***-1.48***	***-1.69***	***-0.54***	***-0.85***	***-0.99***	***-0.72***	***-1.09***	***-1.24***	***-0.60***	***-0.23***	***-0.32***	***-0.39***	***-0.79***	***-0.99***	***-0.14***	***-0.30***	***-0.43***	***-0.30***	***-0.51***	***-0.65***	***-0.17***	***0.38***	***0.30***
	LIVE												**OTHERAGR**											
	RP			RNP			UP			UNP			RP			RNP			UP			UNP		
T	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	-0.06	-0.62	-0.45	0.17	0.17	0.30	-0.02	-0.15	-0.01	0.15	1.80	1.83	-0.26	-3.11	-2.87	0.02	-1.83	-1.64	-0.19	-2.27	-2.07	-0.02	-0.44	-0.34
2	-0.14	-0.75	-0.73	0.11	-0.24	-0.16	-0.09	-0.50	-0.42	0.08	0.38	0.64	-0.38	-1.85	-2.14	-0.08	-1.12	-1.29	-0.29	-1.43	-1.62	-0.12	-0.59	-0.61
3	-0.24	-0.80	-0.89	0.03	-0.27	-0.29	-0.16	-0.52	-0.54	0.00	0.43	0.54	-0.52	-1.94	-2.33	-0.20	-1.18	-1.44	-0.40	-1.48	-1.76	-0.24	-0.58	-0.73
4	-0.34	-0.84	-1.03	-0.06	-0.30	-0.42	-0.25	-0.53	-0.65	-0.09	0.46	0.43	-0.68	-1.99	-2.45	-0.33	-1.22	-1.56	-0.53	-1.51	-1.86	-0.38	-0.56	-0.83
5	-0.47	-0.86	-1.15	-0.17	-0.32	-0.53	-0.34	-0.54	-0.75	-0.20	0.47	0.33	-0.86	-2.01	-2.54	-0.48	-1.24	-1.64	-0.67	-1.52	-1.93	-0.54	-0.54	-0.91
Av	***-0.25***	***-0.77***	***-0.85***	***0.02***	***-0.19***	***-0.22***	***-0.17***	***-0.45***	***-0.47***	***-0.01***	***0.71***	***0.75***	***-0.54***	***-2.18***	***-2.47***	***-0.21***	***-1.32***	***-1.51***	***-0.42***	***-1.64***	***-1.85***	***-0.26***	***-0.54***	***-0.68***
	MAN												**ROIL**											
	RP			RNP			UP			UNP			RP			RNP			UP			UNP		
T	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	-0.59	-10.11	-9.23	0.02	-6.64	-5.95	-0.44	-7.78	-7.03	-0.06	-3.85	-3.33	-0.93	-83.63	-76.52	-0.25	-65.76	-60.05	-0.73	-70.47	-64.42	-0.35	-69.99	-63.74
2	-0.88	-5.75	-6.57	-0.22	-3.80	-4.32	-0.68	-4.56	-5.13	-0.31	-2.75	-2.95	-1.34	-62.42	-63.00	-0.59	-49.12	-49.49	-1.07	-52.70	-53.11	-0.71	-52.66	-52.84
3	-1.21	-5.99	-7.03	-0.49	-3.97	-4.70	-0.94	-4.72	-5.49	-0.59	-2.77	-3.26	-1.80	-64.26	-65.54	-0.96	-50.57	-51.53	-1.44	-54.23	-55.25	-1.11	-54.16	-55.03
4	-1.58	-6.15	-7.34	-0.79	-4.09	-4.97	-1.24	-4.82	-5.74	-0.92	-2.76	-3.51	-2.31	-65.60	-67.37	-1.37	-51.64	-53.02	-1.86	-55.35	-56.80	-1.55	-55.26	-56.64
5	-2.01	-6.18	-7.54	-1.14	-4.12	-5.16	-1.58	-4.84	-5.90	-1.28	-2.72	-3.69	-2.89	-66.30	-68.82	-1.84	-52.20	-54.19	-2.34	-55.94	-58.03	-2.05	-55.83	-57.92
Av	***-1.25***	***-6.84***	***-7.54***	***-0.52***	***-4.52***	***-5.02***	***-0.98***	***-5.34***	***-5.86***	***-0.63***	***-2.97***	***-3.35***	***-1.85***	***-68.44***	***-68.25***	***-1.00***	***-53.86***	***-53.66***	***-1.49***	***-57.74***	***-57.52***	***-1.15***	***-57.58***	***-57.23***
	TRANSP												**SER**											
	RP			RNP			UP			UNP			RP			RNP			UP			UNP		
T	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3	SIM1	SIM2	SIM3
1	-0.15	-4.26	-3.80	-0.03	-3.13	-2.76	-0.12	-3.47	-3.07	-0.04	-2.79	-2.42	-0.08	-2.11	-1.81	0.04	-1.40	-1.16	-0.05	-1.63	-1.38	0.02	-0.85	-0.64
2	-0.22	-2.55	-2.74	-0.08	-1.88	-2.01	-0.17	-2.10	-2.24	-0.10	-1.78	-1.85	-0.12	-1.33	-1.39	0.00	-0.90	-0.93	-0.09	-1.07	-1.09	-0.01	-0.71	-0.66
3	-0.29	-2.68	-2.93	-0.14	-1.98	-2.16	-0.23	-2.20	-2.39	-0.16	-1.86	-2.00	-0.17	-1.39	-1.51	-0.04	-0.95	-1.02	-0.13	-1.11	-1.19	-0.05	-0.73	-0.75
4	-0.37	-2.78	-3.06	-0.20	-2.05	-2.27	-0.30	-2.28	-2.51	-0.23	-1.92	-2.11	-0.22	-1.44	-1.60	-0.08	-0.99	-1.10	-0.17	-1.15	-1.26	-0.10	-0.74	-0.82
5	-0.47	-2.83	-3.16	-0.28	-2.10	-2.36	-0.37	-2.32	-2.59	-0.31	-1.95	-2.20	-0.29	-1.47	-1.68	-0.14	-1.01	-1.17	-0.22	-1.16	-1.32	-0.16	-0.75	-0.89
Av	***-0.30***	***-3.02***	***-3.14***	***-0.15***	***-2.23***	***-2.31***	***-0.24***	***-2.47***	***-2.56***	***-0.17***	***-2.06***	***-2.12***	***-0.18***	***-1.55***	***-1.60***	***-0.04***	***-1.05***	***-1.08***	***-0.13***	***-1.22***	***-1.25***	***-0.06***	***-0.76***	***-0.75***

D: **Total Aggregate Output (XST)**

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	0.84	2.05	2.01	-0.01	0.74	0.70	-0.64	0.99	0.20	0.13	2.31	2.31
2	0.76	1.05	1.15	-0.12	0.01	0.02	-0.99	0.37	-0.33	0.04	0.50	0.80
3	0.66	1.06	1.04	-0.25	0.00	-0.11	-1.39	0.36	-0.54	-0.06	0.50	0.64
4	0.55	1.07	0.93	-0.40	0.00	-0.24	-1.84	0.38	-0.70	-0.17	0.49	0.47
5	0.42	1.08	0.83	-0.57	0.00	-0.35	-2.35	0.41	-0.79	-0.30	0.46	0.31
Av	***0.65***	***1.26***	***1.19***	***-0.27***	***0.15***	***0.00***	***-1.44***	***0.50***	***-0.43***	***-0.07***	***0.85***	***0.91***
	MAN			***COIL***			***ROIL***			***OMIN***		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	-0.37	1.09	0.67	0.00	0.04	0.04	0.00	4.61	4.01	0.05	0.28	0.37
2	-0.68	0.21	-0.21	-0.42	-0.66	-1.03	-0.43	106.26	74.25	-0.34	-0.73	-0.96
3	-1.03	0.17	-0.48	-0.89	-0.30	-1.14	-0.89	96.62	72.44	-0.77	-0.62	-1.31
4	-1.43	0.15	-0.72	-1.44	0.06	-1.20	-1.38	89.36	73.36	-1.26	-0.53	-1.62
5	-1.89	0.14	-0.89	-2.05	0.42	-1.19	-1.94	85.26	75.66	-1.82	-0.46	-1.87
Av	***-1.08***	***0.35***	***-0.33***	***-0.96***	***-0.09***	***-0.90***	***-0.93***	***76.42***	***59.94***	***-0.83***	***-0.41***	***-1.08***
	TRANSP			***SER***			***NTR***					
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb			
1	0.29	-11.48	-8.94	-0.41	-0.56	-0.80	0.33	-3.15	-1.90			
2	0.20	-8.31	-7.78	-0.54	-0.33	-0.67	0.40	-2.95	-2.26			
3	0.10	-8.94	-8.72	-0.70	-0.37	-0.78	0.47	-3.15	-2.59			
4	-0.02	-9.45	-9.54	-0.87	-0.40	-0.86	0.55	-3.32	-2.91			
5	-0.14	-9.83	-10.28	-1.07	-0.42	-0.91	0.65	-3.46	-3.23			
Av	***0.09***	***-9.60***	***-9.05***	***-0.72***	***-0.42***	***-0.80***	***0.48***	***-3.21***	***-2.58***			

E: **Rental rate of industry *j* composite capital (RC)**

	FOOD			*OCROP*			*LIVE*			*OTHERAGR*		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	0.50	-7.31	-6.76	-0.43	-8.55	-8.01	-1.01	-8.53	-8.61	-0.30	-7.39	-6.80
2	0.65	-2.37	-2.98	-0.24	-3.32	-4.00	-0.98	-2.83	-4.09	-0.09	-2.77	-3.19
3	0.84	-2.48	-2.81	-0.01	-3.38	-3.77	-0.95	-2.82	-3.82	0.15	-2.76	-2.94
4	1.06	-2.57	-2.58	0.25	-3.42	-3.48	-0.90	-2.77	-3.45	0.42	-2.74	-2.65
5	1.32	-2.60	-2.34	0.54	-3.40	-3.18	-0.84	-2.65	-3.03	0.73	-2.67	-2.36
Av	***0.87***	***-3.47***	***-3.49***	***0.02***	***-4.41***	***-4.49***	***-0.94***	***-3.92***	***-4.60***	***0.18***	***-3.67***	***-3.59***
	MAN			***COIL***			***ROIL***			***OMIN***		
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb
1	-0.87	-8.16	-8.04	0.02	-0.99	-0.78	-0.20	370.18	307.00	-0.03	-7.25	-5.94
2	-0.76	-2.53	-3.59	0.25	2.01	1.47	0.35	-76.02	-9.85	0.20	0.44	-0.61
3	-0.63	-2.55	-3.31	0.51	1.50	1.44	0.82	-47.83	5.54	0.46	-0.32	-0.83
4	-0.49	-2.54	-2.95	0.81	1.07	1.44	1.29	-25.17	11.98	0.75	-0.91	-0.89
5	-0.33	-2.45	-2.56	1.16	0.73	1.44	1.77	-11.49	13.85	1.09	-1.27	-0.90
Av	***-0.62***	***-3.65***	***-4.09***	***0.55***	***0.86***	***1.00***	***0.81***	***41.93***	***65.70***	***0.49***	***-1.86***	***-1.83***
	TRANSP			***SER***			***NTR***					
T	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb	S4FOOD	S4OILa	S4OILb			
1	-0.11	-20.73	-17.68	-0.75	-9.76	-9.36	-0.21	-11.27	-9.94			
2	0.13	-10.61	-10.91	-0.59	-3.48	-4.48	-0.30	-6.33	-6.81			
3	0.40	-10.37	-10.68	-0.42	-3.47	-4.15	-0.40	-6.62	-7.19			
4	0.71	-10.04	-10.27	-0.22	-3.43	-3.75	-0.52	-6.83	-7.44			
5	1.06	-9.54	-9.81	0.00	-3.30	-3.32	-0.66	-6.92	-7.62			
Av	***0.44***	***-12.26***	***-11.87***	***-0.40***	***-4.69***	***-5.01***	***-0.42***	***-7.59***	***-7.80***			

F: **Wage rate* (W)**

T	S4FOOD	S4OILa	S4OILb
1	-0.42	-9.36	-8.78
2	-0.56	-4.44	-5.37
3	-0.72	-4.60	-5.55
4	-0.89	-4.70	-5.60
5	-1.09	-4.70	-5.57
Av	***-0.74***	***-5.56***	***-6.17***

Appendix F: **Results for Diagnostic and Sensitivity Analysis**

Table 1: Diagnostic 1: **Baseline Simulation Check – Food, and Oil Price Shock**

Iter	Phase Ninf	Infeasibility	RGmax NSB Step InItr MX OK
0	0	4.4422660311E-06	(Input point)
			Pre-triangular equations: 721
			Post-triangular equations: 83
1	0	4.3695401063E-06	(After pre-processing)
2	0	4.8108231168E-10	(After scaling)

Table 2: Diagnostic 2: **Leon Check – Food, and Oil Price Scenario**

---- VAR LEON Excess supply on the last market					
	LOWER	LEVEL	LEVEL	LEVEL	UPPER
		Baseline	*S1SIM1*	*S2SIM1*	
1	-INF	-4.66E-10	-2.91E-11	-1.489E-8	+INF
2	-INF	-4.66E-10	-1.382E-9	-1.042E-8	+INF
3	-INF	.	-6.046E-9	-2.681E-8	+INF
4	-INF	7.276E-12	-7.873E-9	-3.465E-8	+INF
5	-INF	7.276E-12	4.9768E-9	-1.027E-8	+INF

Table 3: **Sensitivity analysis on selected macroeconomic variables**

	GDP	**YG**	**SG**	**IT**	**EX**	**IM**
S1FOOD	*1.23*	*-0.32*	*-1.29*	*1.82*	*-0.22*	*-0.33*
S1FOODhigh	*1.23*	*-0.33*	*-1.29*	*1.83*	*-0.21*	*-0.33*
S1FOODlow	*1.24*	*-0.33*	*-1.29*	*1.83*	*-0.21*	*-0.33*
S2OIL1	*-4.27*	*-2.03*	*-8.88*	*-27.19*	*-2.69*	*-9.58*
S2OILhigh	*-4.31*	*-2.04*	*-8.90*	*-27.32*	*-2.74*	*-9.63*
S2OILlow	*-4.31*	*-2.04*	*-8.90*	*-27.32*	*-2.75*	*-9.63*

Table 4: **Sensitivity analysis on household total income**

	S1SIM1	S1FOODhigh	S1FOODlow	S2OIL1	S2 OIL high	S2 OIL low
RP	*2.38*	*2.39*	*2.40*	*-6.09*	*-6.15*	*-6.16*
RNP	*2.88*	*2.89*	*2.89*	*-5.52*	*-5.56*	*-5.57*
UP	*1.89*	*1.90*	*1.90*	*-5.62*	*-5.66*	*-5.67*
UNP	*1.48*	*1.49*	*1.49*	*-4.32*	*-4.35*	*-4.36*

Appendix G: **Food and Oil Price Shocks with Unemployment Assumption**

The additional results presented here reflects the macroeconomic and households implications of 37% and 60% increase in the international prices of food and oil, respectively, based on the assumption that some level of unemployment exist in the country. To carry out these simulations, the labour market closure rule was modified. Accordingly, equation 69 was modified such that labour supply was made up of labour demand and unemployment. Thus, equation 69 becomes:

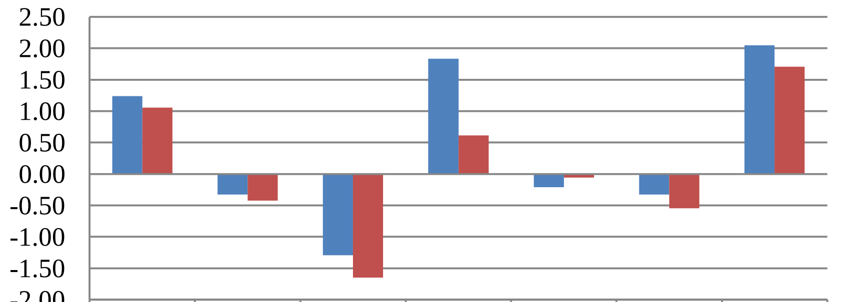
$$\sum_{j} LD_{j,t} + UE_t = LS_t \ .$$

With this specification wage is held fixed in the model to maintain equilibrium in the labour market. The simulations result, discussed hereunder, show the extent to which unemployment affects the macroeconomic as well as households' income and consumption. The discussion is made in comparison with the scenario with full employment assumption.

(a) Macroeconomic Effects of Food and Oil Price Shock Scenario

Figure 1a and 1b presents the macroeconomic effects of a 37% and 60% shock to international price of food and oil, respectively, in the case of full employment and unemployment assumptions. Figure 1a shows that the effect of the shock (in terms of direction) is the same in both case scenarios; the magnitudes of the effects, however, differ slightly except in the case of total investment. The significant decline in investment may be attributed to the decline in government savings (1.65%) which is noted to be higher than the case on full employment equilibrium. The effects on GDP and aggregate household income are slightly lower when some level of unemployment is assumed in the model. Figure 1b also shows that with the unemployment assumption, macroeconomic variables of interest also move in the same direction as in the case of full employment. The effects, however, differ in magnitude. The impact on the macroeconomic variables of interest is less with the unemployment assumption. For instance, GDP declined by 3.48%, on average, over the simulation period compared to 4.31% recorded in the case of full employment equilibrium.

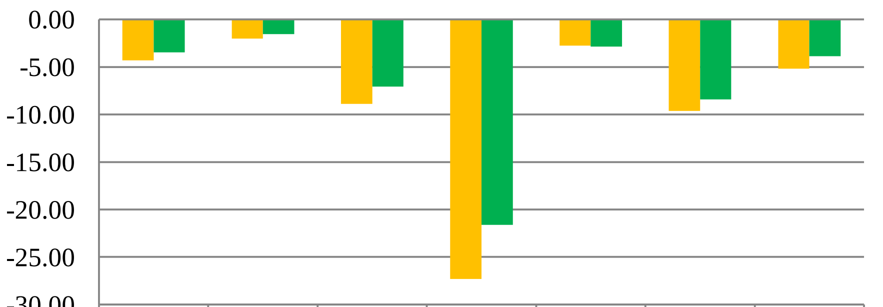
Figure 1a: **Macroeconomic Effects of 37% Shock to World Food Price**



	GDP	YG	SG	IT	EX	IM	YH
S1FOOD	1.24	-0.33	-1.29	1.83	-0.21	-0.33	2.05
S1FOOD+U	1.05	-0.43	-1.65	0.62	-0.06	-0.55	1.71

Note: S1FOOD+U simulates the effects of a 37% shock to world food price with unemployment assumptions
S1FOOD simulates the effects of a 37% shock to world food price with full employment assumptions

Figure 1b: **Macroeconomic Effects of 60% Shock to World Oil Price**



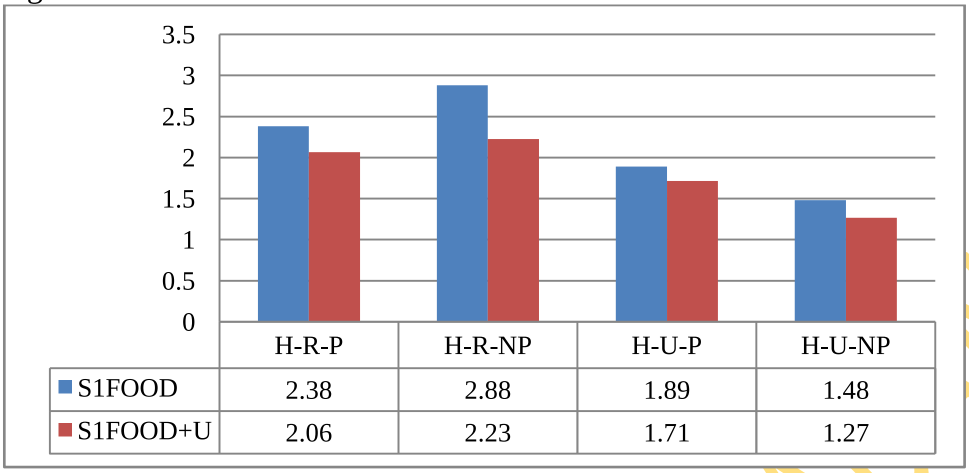
	GDP	YG	SG	IT	EX	IM	YH
S2OIL1	-4.31	-2.04	-8.90	-27.32	-2.75	-9.63	-5.18
S2OIL1+U	-3.48	-1.54	-7.05	-21.61	-2.85	-8.40	-3.88

(b) Households Effects of Food and Oil Price Shock Scenario

(i) Income Effects

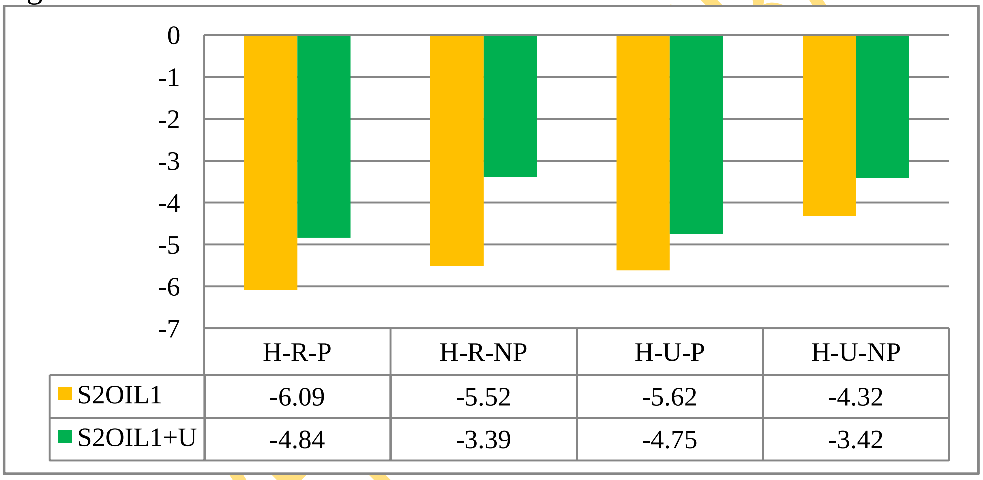
Figure 2a indicates that households' income effect in the case of unemployment assumption (S1FOOD+U) is not different from the full employment scenario, in terms of the direction. However, it is observed that the income of all household categories did not rise as much when compare with S1FOOD. The is not surprising given that wages have been held fixed in the model in order to equilibriate the market for labour. The significant decline in rural non-poor households' income compared to other household category may be attributed to their lower share of total labour income. On the other hand, Figure 2b shows that negative effect on households' income when wage rate was the equilibriating force in the labour market was not as severe as when employment levels had to adjust to clear the market for labour. Given that the wage rate is fixed shocks to the international price of oil which distorts allocation of factors does not affect the wage income of households.

Figure 2a: **Households Income Effects of 37% Shock to World Food Price**



	H-R-P	H-R-NP	H-U-P	H-U-NP
S1FOOD	2.38	2.88	1.89	1.48
S1FOOD+U	2.06	2.23	1.71	1.27

Figure 2b: **Households Income Effects of 60% Shock to World Oil Price**



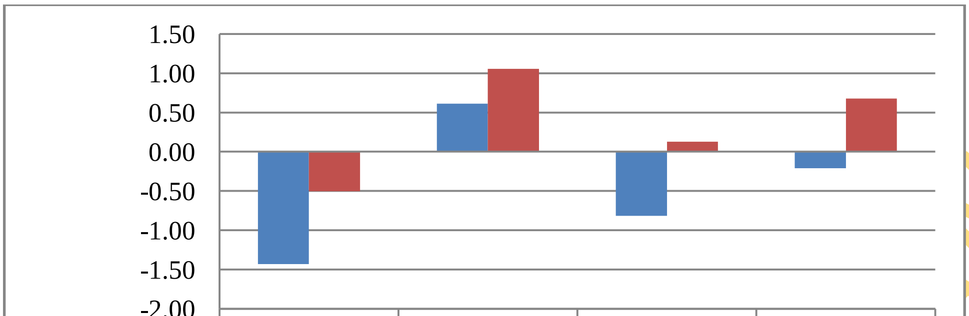
	H-R-P	H-R-NP	H-U-P	H-U-NP
S2OIL1	-6.09	-5.52	-5.62	-4.32
S2OIL1+U	-4.84	-3.39	-4.75	-3.42

(ii) Consumption Effects

Results on the consumption effect indicate that households fared better when some level of unemployment is assumed in the model. Despite the fact that households income did not increase as much (when compared to the scenario of full employment), households consumption improved (Figure 3a). For instance, urban poor and non-poor households' consumption declined by 0.82% and 0.21% in the full employment case but increased by 0.13% and 0.68% respectively, in S1FOOD+U. The decline in rural poor households' consumption of 0.5% in the unemployment case was less than the 1.43% recorded in the case of full employment. This suggests that there was a significant fall in the prices of goods sold in the domestic market which raised the real income of the households. The corollary is observed in the oil shock scenario.

Consumption of all household categories worsened despite less destabilizing negative effects on their income.

Figure 3a: **Households Consumption Effects of 37% Shock to World Food Price**



	H-R-P	H-R-NP	H-U-P	H-U-NP
S1FOOD	-1.43	0.61	-0.82	-0.21
S1FOOD+U	-0.50	1.06	0.13	0.68

Figure 3b: **Households Consumption Effects of 37% Shock to World Food Price**

	H-R-P	H-R-NP	H-U-P	H-U-NP
S2OIL1	-2.45	-2.60	-2.70	-2.01
S2OIL1+U	-4.92	-3.74	-5.21	-4.45