DETERMINANTS OF DEMAND FOR TRADABLE COMMODITIES IN A SMALL OPEN ECONOMY: A CASE OF DIESEL IN UGANDA

By

MUKISA SIMON PETER TURKER
BAED UCU (HONS), MAEPP (MUK)

A dissertation submitted to the college of Business and Management Sciences in partial fulfilment for the award of the degree of Master of Arts in Economic Policy and planning

Supervisor: DR. James W Muwanga

December 2011

DECLARATION

I Mukisa Simon Peter Turker, hereby declare that the work I have presented is solely the result of my efforts (except where quoted) and that it has never been submitted before by any one for the award of a degree at any university or institution of higher learning.

Signature ………………………   Date: ....

CERTIFICATION

This certifies that the under-signed supervisor has read through this thesis in the process of guiding the author and there by recommend it for submission to the school of graduate studies Makerere University in partial fulfilment of a Master of Arts degree in Economic policy and planning of Makerere University.

Signed... Date.....................................

Dr. James W. Muwanga

ACKNOWLEDGEMENTS

I thank the almighty Heavenly father Lord God King of glory for having enabled me to develop my career and faithfully helped me throughout the course of the study. My special thanks go to my supervisor Dr. Muwanga James for his guidance, constructive comments and critical remarks.

I would also express my thanks to Dr. Ndatira Chris Mukiza and the entire staff of UBOS for allowing me to access the resource centre and the necessary Data as far as this research is concerned. Special thanks are also extended to Mr. Nyenje Ronald URA Research section and the staff of Bank of Uganda (BOU) for kindly providing me with the necessary materials. I would also like to extend my thanks to Dr. Buyinza Faisal for his valuable comments on Econometrics works.

I would wish also to express my thanks to my parents Rev. Christopher Goowa and Ruth Goowa and all my friends who directly or indirectly provided me with moral support during the study.

Finally, I would like to thank my wife Rachael and son Austin whom I denied time and attention while busy trying to finish up this project.

DEDICATION

This work is dedicated to my beloved parents Rev. Christopher and Ruth Goowa. My beloved Wife Rachael and son Mukisa Austin and the entire Goowa Family for your un measurable efforts towards my education. May the almighty Heavenly father lord King of glory reward each one of you with good health and wealth.

TABLE OF CONTENTS

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AFDB	African development bank
ADF	Augmented Dickey-Fuller
AGO	Automotive Gas Oil
BIK	Bituminous Illuminating Kerosene
EIA	Energy Information Administration
ERA	Electricity Regulatory Authority
ESMAP	Energy Sector Management Assistance Program
GDP	Gross Domestic Product
HEP	Hydro Electric Power
HFO	Heavy Fuel Oil
LDCs	Less Developed Countries
MEMD	Ministry of Energy and Mineral Development
MW	Mega Watts
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
OPEC	Organization of Oil and Petroleum Exporting Countries
Pgas	price of Gasoline
PMS	Premium Motor Spirit
PV	Photovoltaic
UBOS	Uganda Bureau of statistics
UEB	Uganda Electricity Board
UIA	Uganda Investment Authority
UNDP	United Nations Development Programme
URA	Uganda Revenue Authority

US$	United States dollars
UShs	Uganda Shillings
VAR	Vector Auto regression
VAT	Value Added Tax
VECM	Vector Error Correction Model

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In this research paper, attempts are made to identify determinants of demand for diesel in Uganda. The study estimates diesel demand using time series data starting from 1981 to 2010. The primary objective of this study is to investigate the determinants of demand for diesel in Uganda. In addition it estimates demand elasticity for diesel in Uganda using time series econometric techniques.

Accordingly, the study used a double logarithm model to investigate this issue together with a list of tools of analysis such as vectors error correction model, which uses the impulse response function and variance decomposition model to show the response of variables to shocks. The study also investigated both short run and long run elasticities for per capital income and price. The results from the study identified only four major variables that were the major drivers of demand and these include; price of diesel, number of diesel consuming vehicles, real foreign exchange rate and real price of diesel. These factors were responsible for high demand in the long run and in short run apart from the number of diesel consuming vehicles which was only significant in the long run. The results from co integration revealed a maximum of only six co integrating equations and the error correction models showed time of adjustment of variables to given shocks. Real per capita income and real price of diesel could stabilize with given shocks in the long run. The price elasticity of demand and income elasticity of demand were in contrary with expected signs.

CHAPTER ONE: INTRODUCTION

1.1: BACK GROUND TO THE STUDY

Uganda is a landlocked developing country whose economic growth and development heavily relies on Energy as an essential factor and a key aspect in every form of development. To be more specific, energy is required for industrial growth, locomotion, domestic lighting, heating and cooking, and for many other factors. In fact Petrie (1961) states that it is less well known that many ordinary things in everyday use are derived from petroleum by the skill of the industrial chemist.

There are generally two categories of energy sources, commercial energy and traditional energy. Biomass such as firewood, cow dung and agricultural residues are the major sources of traditional energy in Uganda while petroleum products are the major sources of commercial energy in the country. Petrie (1961) states that the present great demand for crude petroleum which is later refined to obtain all the other petroleum products is met by sinking wells deep into the rocks of the earth's crust in which it is imprisoned in vast amounts and in fact the word PETROLEUM comes from two Latin words PETRA = rock and OLEUM = oil. All petroleum products in Uganda are imported, thereby exposing the economy to fluctuating and exorbitant prices together with uncertainty with regard to availability. Petroleum products are many ranging from PMS (Petrol), AGO (Diesel), BIK (Kerosene), jet fuel among others. However, the products may even range to more and more owing to the refinery made and the stages involved in the refinery process. Other than Biomass and petroleum products in the country, other sources of energy in Uganda include; water falls, coal, hot springs, and solar.

According to the Ministry of Finance, Planning and Economic Development (1999), by the year 1997, petroleum and electricity combined together constituted to 6 percent of the annual energy consumption mix while the remaining 94 percent of energy was obtained from Biomass. Uganda's per capita petroleum consumption is only 17Kg; comparing this to the 70Kg of sub Saharan Africa clearly indicates low petroleum consumption for the country for both domestic and industrial use UNDP/World Bank ESMAP, (1996). This means that the country heavily relies on the traditional biomass source of energy whose negative impact has left the country struggling with associated challenges such as climate change, deforestation and soil erosion among others.

Table 1.1: Annual Demand of Oil Products by Type (Tonnes)

Year	Premium	Kerosene	Diesel	Aviation	Fuel oil	LPG	Total
1994	118521	25090	79701	33711	16212	693	273928
1995	141141	32301	96316	24866	24566	1005	320195
1996	154510	34771	99478	33286	29468	1420	352934
1997	150487	36432	100497	35179	34124	1629	358348
1998	163180	44631	119623	47838	39384	1977	416634
1999	172232	45513	143773	40008	42340	2200	446066
2000	161893	42122	149821	31687	36087	3082	424692
2001	170018	41654	165789	34605	38591	2892	453549
2002	173003	68271	156292	31733	32391	3116	464806
2003	131897	30523	176077	52775	41889	3805	436967
2004	158342	37005	208782	62356	53313	4500	524298
2005	147946	29877	255659	70078	44423	4488	552471
2006	168407	32173	333959	70916	38289	5800	649544
2007	162956	25732	371297	72981	34384	7273	674623

Source: MEMD.

NOTE: Values for Premium, Kerosene, Diesel and Aviation were provided in m^3 and were converted to tonnes using densities of 850kg/m^3, 750 kg/m3, 800 kg/m^3, and 788 kg/m^3 respectively.

The combined percentage of fire wood and charcoal usage in the country is put at 98 percent, while the other 2 percent is shared equally between electricity and Kerosene (UBOS 2001). Given the above findings, the role of petroleum cannot be under looked. In fact petroleum contributes to about 66 percent of the total commercial energy consumed and 23 percent of the tax revenue Uganda Revenue Authority (2003). According to Uganda Investment Authority (UIA), Petroleum contributes significantly towards the financing of public expenditures in Uganda (UIA 2000)

Table 1.2: The contribution of taxes on Petroleum products to total revenue in Uganda

Year	1995/96	1996/97	1997/98	1998/99	1999/2000
Actual contribution (Million UShs)	150,962	197,332	187,927	193,208	196,800
Percentage Contribution	22.3	27.3	23.3	19.7	19.2

Source: Uganda Investment Authority

At the moment (2009/2010) the cost of importing Petroleum products is about $728,624m (URA 2009), contributing to about 17.1% of the total import bill per year. This comes as an effort to support the endeavour to solve the acute power shortage in the country through the encouragement of thermal power generation, the Government agreed in February 2006 to waive taxes on Diesel used by commercial generators above a certain capacity.

TABLE 1.3 Uganda's Petroleum import bill as a percentage of total import bill.

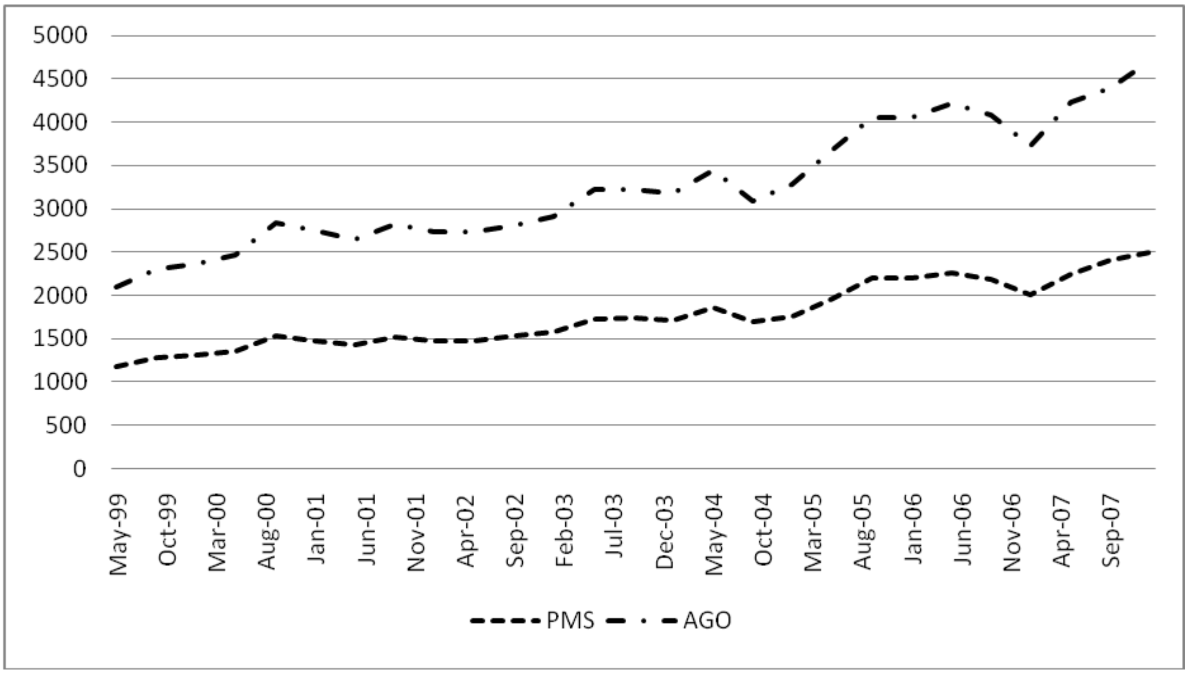
Year	Total import bill (million US$)	Petroleum import bill (% of the total import bill)
1994/95	77,770	8.0
1995/96	104,834	7.8
1996/97	115,987	8.9
1997/98	111,566	6.8
1998/99	121,739	8.9
1999/00	1,362.9	8.9
2000/01	973.2	8.2
2001/02	1,006.6	12.2
2002/03	1,073.1	16.2
2003/04	1,375.1	13.6
2004/05	1726.1	12.6
2005/06	2054.1	16.7
2006/07	2557.3	20.6
2007/08	3495.4	18.5
2008/09	4.6	18.5
2009/10	4.3	17.1

UBOS Statistical abstracts

NB Import bill figures for 2008/09 and 2009/10 are in billions US$ while the rest of the years are in million US$

But in spite of that, these fuel guzzling measures have adversely aggravated the fuel price hikes, as the country becomes more dependent on diesel powered thermal power, leaving Uganda with one of the most expensive fuel in Africa.

Fig. 1.1: Average Pump Prices for Petroleum Products in Uganda (Kampala Pump Prices, Shillings per Litre, May 1999-Jan 2008)



Source: Bank of Uganda and UBOS

Despite the ever increasing fuel prices, the demand and sales for the same has persistently increased to worrying levels as can be noticed in appendix 2. One of the reasons why at times the price of fuel shoots so high is the problematic supply from Kenya that has frequently caused supply shortages and, at times, rationing by fuel suppliers. This is mainly caused by inadequate pumping capacity of the pipeline to Eldoret that can not cope with the growing fuel demand in the countries in the hinterland that rely on Kenya for supply. This has been aggravated by acts of vandalism that have often damaged the pipeline in order to steal petroleum products and power failures that sometimes stop pipeline operations.

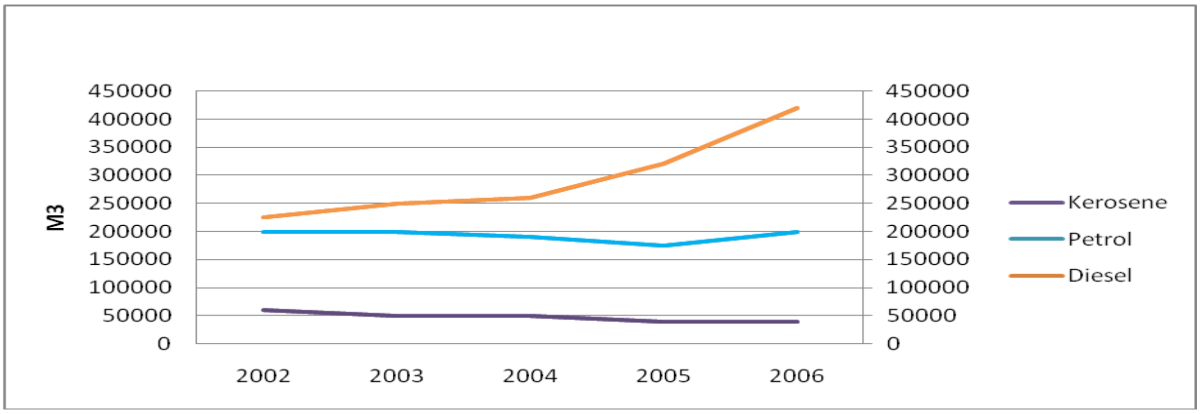
Table 1.4: Petroleum product cost structure (As percentage of retail pump prices)

	Petrol	**Diesel**
FOB	17	19
Shipping to Mombasa	3	4
Inland transport etc	10	11
Uganda wholesale	17	21
Uganda retail	4	4
Uganda taxes	49	42
Retail pump prices	100	100

Source: UNDP/ World Bank – ESMAP, 1996

This together with relatively high excise duties and VAT on Petroleum products as already seen in table 1.4 above has ensured that the mark-up on import oil is very high. The tax on Petroleum products accounts for a large share of total government revenue, amounting to about 19.4 per cent of the total revenue (Ministry of Mineral and Energy Development 2008). The VAT rate is now 18 per cent, and excise duties on petrol are about USh.660 for a retail price of about Ushs. 2,450, and on diesel USh.400 per litre, for a retail price of about UShs.2300, which accounts for up to 33 per cent of the final sale price. Added to import duties, the tax rate on fuel is estimated at over 80 per cent. These high taxes levied on Petroleum products combined with the impacts of high transportation costs makes fuel prices in Uganda one of the highest in Africa.

Figure 1.2: Sales of selected petroleum products in Uganda 2002 – 2006



Source: UBOS (2008)

Due to the increased economic activity in the country, the demand for more petroleum products has continued to rise as earlier stated to unsustainable levels so as to meet the ever increasing demand for the scarce HEP in the country. This is further reflected in the table below.

Table 1.5: Uganda's total petroleum products consumption

Year	**Total consumption(in barrels)**
1980	5.000
1981	3.200
1982	3.800
1983	3.700
1984	3.800
1985	4.100
1986	4.496
1987	3.853
1988	5.876
1989	5.412
1990	5.787
1991	6.450
1992	6.588
1993	6.844
1994	7.015
1995	7.014
1996	6.968
1997	7.187
1998	8.290
1999	8.290
2000	8.561
2001	9.522
2002	9.930
2003	10.687
2004	10.874
2005	11.390
2006	12.879
2007	13.900
2008	13.400
2009	13.000

Source: MEMD

1.1.1: The HEP generation and supply in Uganda

Over the recent years, Uganda experienced electricity supply shortages largely caused by the decline in hydro-generation as a result of persistent drought that hit most of the country which lowered the water levels of Lake Victoria. These shortages have been exacerbated by the lack of generation "reserve margin" and inelastic generation capacity. In order to address this power supply problem, government has procured thermal generation using diesel. In May 2005, 50 MW of diesel (AGO) based generation was commissioned at Lugogo and in December 2006 an additional 50 MW was commissioned at Kiira under short term contracts. There are now plans to replace these expensive AGO based generators with heavy fuel oil (HFO) based generation hence an increase in the demand for diesel. For quite a long period of time in Uganda, the responsibility of generation, transmission and distribution of HEP was entirely done by Uganda Electricity Board (UEB), a government entity. UEB had a task of ensuring that people in this country are connected to the national grid as well as ensuring that more power is generated to ensure that the supply meets the ever increasing demand of a developing country. However, with time the parastatal was overwhelmed due to the fact that it was constrained by the budget as allocated by the government and it could not deliver as expected and hence it became inefficient.

Much of the electricity network in Uganda is at present poorly maintained and the country experiences frequent power cuts. Just 3-5 percent of the population have access to electricity and many towns, especially in the North of the country are without electrical power. In the rural areas only about 2 percent had access to electricity, of which less than half was provided through the national grid, the remainder coming from household generators, car batteries or solar photovoltaic (PV) units. About 97% of Uganda's population do not have access to electricity.

According to MEMD (2000), Uganda will require 2,000 Megawatts (MW) electricity by the year 2025 to run its industries and homes. To achieve this, more than $3.5 billion (about Shs623 billion) will have to be sourced and spend in the energy sector. Within 20 years from now the country must generate an additional 1700MW to meet its demand capacity. Uganda is currently facing a huge electricity supply deficit, as over 90 percent of the country's population is not connected to the national grid.

The installed capacity in Uganda is about 300 MW, over 98 percent of electricity is generated by the hydroelectric plant at Owen Falls (the 180 MW Nalubaale station and the 200 MW Kiira station with five 40 MW units of which three have been installed) on the Victoria Nile. There exists a small hydro power station at Maziba with an installed capacity of about 2 MW and independent power generation at Kilembe Mines and Kasese Cobalt Ltd with a combined capacity of over 15 MW. It has been estimated that there is another 80 MW of privately installed captive generation capacity.

The previously wholly government-owned utility, the Uganda Electricity Board (UEB) is the organisation that is responsible for supplying electrical power in Uganda. The Ugandan government had pursued a reform programme of the organisation since 1999, but its privatisation only came into effect in 2000. The restructuring of the utility resulted in the UEB being divided into separate business units, under the sections of power generation, transmission and distribution. The aims of the privatisation were to increase private investment in the electrical power sector, to meet increasing demand for electricity and extend power supply to more areas in Uganda, and to improve quality and reliability of the electrical power supply.

The UEB is now focusing on identifying available sites that hold micro hydro potential. The UEB had developed two sites of hydropower generation and private developers developers also developed another two. These sites include Mubuku II (5 MW), Kisizi (0.075 NIW) and the 1.25 MW Kikagati station (which has now been decommissioned). Paidha (7.5 MW), and Ishasha (4.5 MW) are in the process of planning.

Table 1.6: Uganda; Electricity Capacity and Generation: 1995-1999

Capacity/Generation	**1995**	**1996**	**1997**	**1998**	**1999**
Installed capacity					
Owen falls dam	177.0	180.0	180.0	180.0	180.0
Other stations	3.4	3.0	3.0	3.0	3.0
Total capacity	180.4	183.0	183.0	183.0	183.0
Units generated (million kWh)					
Hydro-Electric	1056.3	1129.0	1217.3	1232.4	1340.4
Diesel	1.1	1.1	1.2	1.2	1.2
Total units Generated	1057.4	1130.1	1218.5	1233.6	1341.6
Of which					
Transit & Distribution losses	342.3	296.5	340.1		
Units accounted by consumption	713.7	831.2	878.3		
Maximum Demand (MW)	173.6	177.0	178.6	179.8	180.0
Annual Load Factor (%)	70	71.0	77.9	78.3	85

Source: Uganda Bureau of Statistics. 2000 Statistical Abstract

Uganda faces a deficit in power production which has contributed to the increased demand for diesel powered generators hence an increase in the diesel demand. However, Uganda's strategic geographic location with reliable rainfall almost throughout the year favours natural water bodies that if developed can lead to several kilo megawatts of electricity to be produced which can help to curb the ever increasing demand that is not met by supply. Such water bodies/sites together with their estimated capacity (mw) can be seen as presented in appendix 1

1.2: RESEARCH PROBLEM

The ever increasing demand for diesel not only for transportation but also for power generation that is not met by sustainable supply continues to exert high pressure to Ugandan economy for development. This high demand that is not met by supply has resulted into ever increasing fuel pump prices, High transport fares and High cost of production. This has negatively affected peoples' welfare as well as their standards of living hence continuous cries and strikes. A lot has been attempted by the government to address the problem by improving on the roads from Busia – Malaba boarder to Kampala, putting in place a ferry as well as putting in place a pipeline but the prices continue to rise due to increased demand that is not met by the supply. There fore there is need to have a thorough understanding of what exactly determines this demand.

1.3 Objective of the study

The primary objective of this study is to investigate the determinants of demand for diesel in Uganda. In addition it estimates demand elasticity for diesel in Uganda using time series econometric techniques. In this regard, both short and long-run estimation are made, and finally conclusions based on the estimation result are made. Specifically, the study relay on diesel consumption trends to the various sectors and its importance for economic development. In addition, based on the findings derive appropriate policy recommendations for improved demand management for commercial energy consumption more especially transportation.

1.4 Justification and Significance of the Study

Besides being an essential input in the production processes, energy is also a direct requirement of people's daily lives. This explains why energy policy is a vital aspect of the overall development policy of the country and how energy policies are designed and implemented influences structure of the country’s economy.

The objectives to be pursued in this study postulate the determinants of demand for diesel consumption. The identification of factors affecting energy consumption, specially the demand for diesel, will indicate possible areas where action in energy development can exert significant influence on economic development. By providing such insight, this paper will also be useful in the formulation of commercial energy specific policies in Uganda.

In recent years, decision makers in various countries have realized that energy sector investment planning should be carried out on an integrated basis (Richard, 1985). Most existing studies on commercial energy particularly demand for diesel has concentrated on developed countries. Hence, this study will give some insight in this area.

Unfortunately, most of Uganda's petroleum products consumed are imported. So achieving energy-economic long-term interests on the imported petroleum depends on the internal energy action taken by the government and sound planning must begin with a good grasp of the facts of energy and economic relations. I think the development of econometric tools which enhance understanding of the factors influencing the demand for diesel will give more information about future energy flow. Moreover, the future commercial energy consumption and economic development are essentially interacting and therefore energy planning should be suggested. However, these suggestions must be flexible enough to accommodate developments as they occur. One may ask why this study focuses on diesel as a commercial energy in Uganda. The main reason is that, the impact of diesel largely influences the country's economy, especially in the transport sector. Goods and services are carried from one place to another through the means of transport. Thus, the findings of this study will form a useful input into the literature and policy implications particularly diesel (transport fuel) and even provoke further studies in the sector.

1.5 Scope of the Study

The study employs yearly data from 1981 to 2010 to estimate determinants of diesel demand function in Uganda during this period. Specifically, the study will focus on diesel demand in the transport sector. The period is chosen on the basis of the availability of reliable data.

1.6 Organization of the Study

The paper is structured as follows: The next chapter reviews the theoretical and empirical evidence of previous studies on determinants of diesel demand. Chapter three presents the data and methodology while chapter four discuses empirical results. Finally, concluding remarks and policy implications presented in chapter five.

1.7: ANTICIPATED LIMITATIONS OF THE STUDY

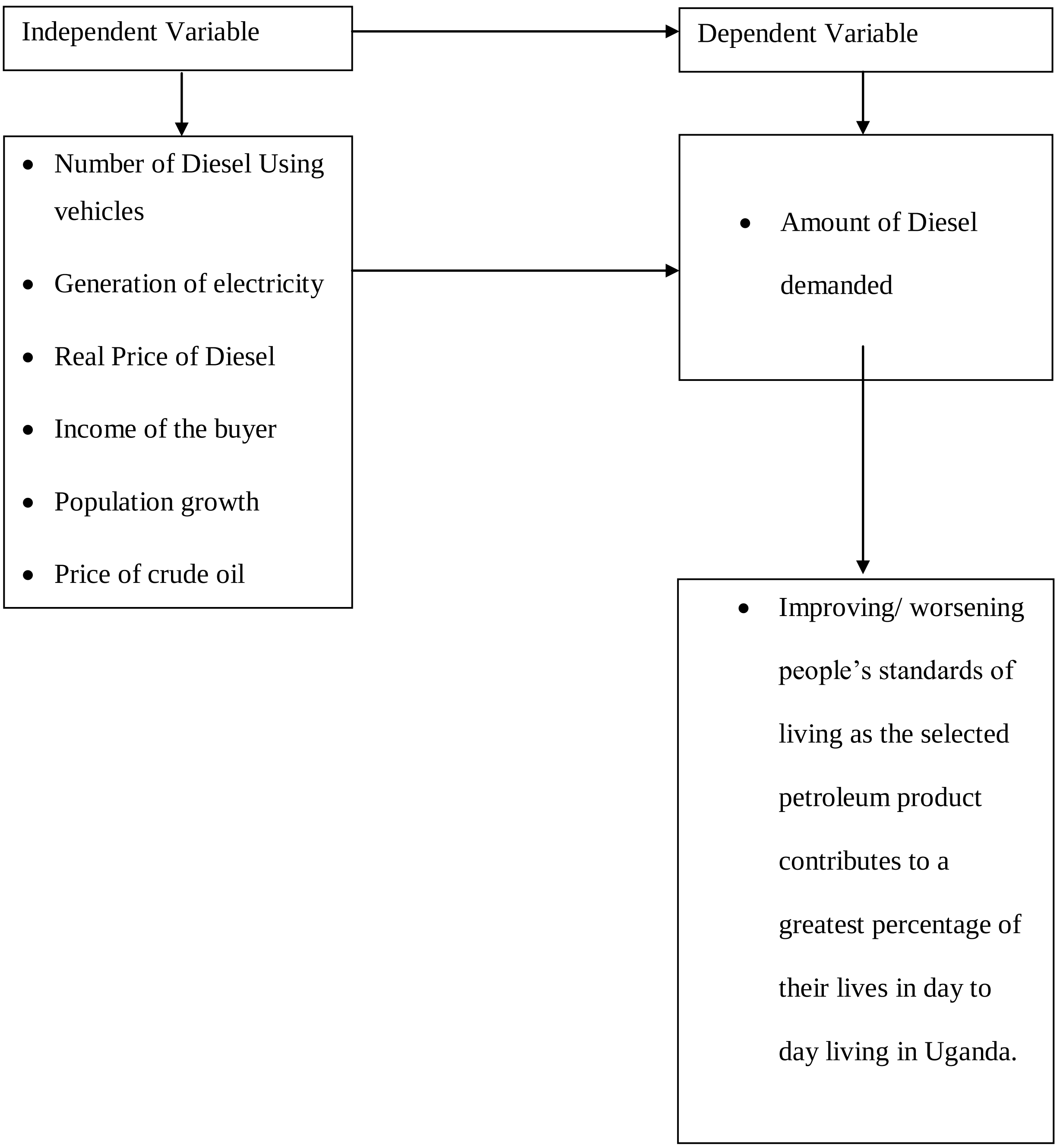
The results of this study may be negatively affected by a number of projected factors/limitations that are likely to have a negative impact on the generation of proper and generally applying theory on determinants of demand for selected diesel in Uganda if not easily detected and mitigated.

The researcher anticipated limited resources in terms of financial, material, and non material resources such as time required to have a conclusive research which may be not enough given the urgency of the project and the researcher's current individual capacity as the main source of funding unless external funding is obtained.

The researcher also anticipates meeting problems in data collection that could affect the final results. The research may be affected by communication problems; obtaining and maintaining rapport may be limited by respondents' wrong perceptions of the purpose of research that could lead to exaggerating, with holding of important information. The researcher is cautious of the fact that some respondents are critical about their business incomes and social matters being private affairs and thus not for public attention. However, the researcher will tend to precisely and concisely explain to respondents the purpose of the study and promise anonymity of the responses.

Given the skills and techniques gained by the researcher from the lectures more especially those of research methodology, he will try to carefully and cautiously detect and manage these anticipated limitations that may appear in the course of the study.

Figure1.3: Conceptualisation of the problem



Note: Arrows represent causal/resultant effect relationship between variables.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Several studies have been carried out in trying to come up with the factors that determine the demand for petroleum products in developed and developing countries however, Uganda's case remains largely uncovered. The available literature ranges from theoretical to empirical analysis. The main focus of this chapter is to review the theoretical and empirical literature related to the on going study.

According to Uganda's Electricity Regulation Authority (ERA), three issues are put forward as the key factors determining the demand for petroleum products in developing countries and these include number of vehicles, generation of electricity and level of economic activity. However, Price of the given petroleum product, income of the buyer, gift of the energy resources, the population growth, industrial investment and trade, availability and price of alternative energy sources as well as government policy regarding importation and pricing of petroleum products are some of the factors put forward by Gately and Shane (1997), as being the determinants of demand for petroleum products in developing countries. In Uganda for instance there is a 50% tax imposed on both Petrol and Diesel and this is directly reflected on the final consumer prices at the refuelling stations hence impacting the consumer's demand.

The World Bank (1992) on the other hand subjects the distortion in the prices of oil to the subsidisation of petroleum products however; the reverse is true in low developing countries where governments impose a lot of taxes onto petroleum hence hiking the final prices at the refuelling stations which lowers the demand of the different petroleum products. There is therefore need to have a clear policy designed so as to check on the distortions on the demand for petroleum products either way.

2.2 Theoretical Literature

In recent years, the energy sector of developing countries (Uganda inclusive) has exhibited a dynamic character. In addition to the important changes in the shares of consuming sectors and fuels in aggregate demand patterns, the energy consumption trends of these countries have moved steadily upwards. This, together with the slowdown in the growth of total energy consumption in the industrialized countries, has underlined the rapidly growing role of developing countries in the world energy market. For instance, according to OPEC review (1994), the share of developing countries in world energy consumption rose from 10 % in 1970 to about 20 % in 1992, while the share of OECD countries fell from 65 % to 51 % in the same period. The annual average energy consumption growth rate of developing countries was about 5.5 % in the period 1970-92, compared with 1% per annum for the OECD countries in the same period. There are several economic, social and demographic factors behind these trends of the past two decades.

Theoretically, the demand for a good or services is determined by its own price, prices of other goods, income, and geographical, demographic as well as environmental factors. The relative energy costs and their supply stability are therefore expected to have an influence on diesel consumption. If other factors remain constant, while the price of one energy form rises, it will be costly to continue consuming this particular source of energy.

Therefore, to maximize utility, given the limited level of money income, a consumer will reduce consumption and increase the consumption of another form (substitute) whose price has decreased or remained constant (Pindyck, 1980).

From the consumers' point of view, the demand for diesel is a derived demand from the services it provides within the transport sector. For example, individuals require diesel for their private cars to provide private and public transport of goods and passengers.

Most studies on gasoline and diesel demand have focused on the developed countries with few studies being undertaken for developing countries especially the African countries including Uganda.

There are different factors that influence the demand for diesel. We assume that the original demand is for transportation with related characteristics such as comfort and status. Therefore, diesel demand is determined in a number of separate steps which are sequential. The first is the decision to own a car, and then comes the decision on its utilization. From the stand point of a utility function, it is easier to conceive a function for individual consumer. As Archibald and Gillingham (1978) showed, the influence of social status such as age and education on individual diesel consumption conditions at the region levels is not necessarily sufficient at the individual level.

Dahl and Sterner are mostly known by their studies on gasoline demand which at times is an alternative to diesel usage. Following Dahl and Sterner (1990), the most important explanatory variables in this case are the level of economic activity and the relative price of gasoline. Like most other commodities, we assume that the demand for diesel increases with income, ceteris paribus. Furthermore, assuming that diesel is a normal good, its demand is inversely related with prices.

Dahl and Sterner (1991) further argued that in a static model diesel demand is a function of real price of diesel and real income. He also argued that in the dynamic model diesel demand is not only affected by current period but also past time. This is because if variables determining the demand for diesel change in a given year, some consumers react with a lag due to the force of habit. As a result current consumption of diesel is not only a function of current income and price structures but of previous incomes and prices as well.

Similarly Dahl and Sterner (1992) modelled demand for transport fuel. Accordingly, they hypothesized that people adjust consumption only partially to changes in price and income because of the inflexibility in the stock of consumer durables.

Moreover, Franzen and Sterner (1995) and Rogat and Sterner (1997) gave more insight regarding the determinants of gasoline demand in OECD and some Latin American countries. They argued that demand for transport fuels is deriven from the demand for transportation itself and therefore has at least two component adjustments, namely vehicle utilization and the composition of the vehicle stock. Given that cars are long lived assets, demand adjustment necessarily occur over a number of years. They used static and dynamic models for the adjustment process.

Ishiguro and Akiyama (1995) observed that income and price elasticities provide a quantitative measure of the impact of economic activity and energy prices on energy demand. Further they argued that total energy demand is the sum of demand in the various sectors of the economy. The sectors they considered include; transportation, industry, household and agriculture sectors.

MacRae (1994) gave similar factors to the one used earlier by Baltagi and Griffin (1983) to facilitate comparison. According to him, Gasoline demand is a function of distance travelled per vehicle, number of vehicles and efficiency (efficiency is distance travelled per unit of gasoline). Moreover, gasoline demand (gas) is normalized on a per vehicle basis, and utilization is hypothesized to depend upon the real price of gasoline (Pgas/PGDP) and real per capita income (Y/Npop).

More generally, Gately and Streifel (1997) analyzed the growth in oil demand. They observed that much of the growth in world oil demand is affected by GDP, population and price of oil. They also examined several alternative equation specifications of per capita oil product demand as a function of per capita real income and the real price of crude oil.

Wohlgemuth (1997) gave some insight regarding the determinant of demand for transportation fuels. Accordingly, income, both in absolute and in per capita terms, is the most important determinant of demand for transportation fuels. In general, transport demand rises with income, although this relation is not consistent across countries. When comparing countries with similar per capita GDP, the corresponding per capita transport energy consumption can vary considerably. He also argued that changes in fuel prices are also important for the determination of transport fuel efficiencies and energy consumption. For instance, gasoline and diesel prices vary substantially across countries and account for part of the difference in per-capita fuel consumption. Moreover, he explained that the determinants of transportation are grouped into economic, socio-demographic, and geographic factors, which, of course, interact. Economic determinants are principally income and the cost of transport. Socio-demographic factors include the links between family size and structure, gender, work status, and age distribution of the population. Finally, geographical condition also influences transport demand through population density and distances between destinations.

According to Barnes, et.al (1984) a country's demand for energy is linked with factors such as size of population, degree of urbanization and industrialization, patterns and levels of technological development. Likewise, Hosier, et.al (1993) argued that the demand for energy is determined by the price of fuel used, the price of other alternative or competing fuels, income and other characteristics of the residents and climatic variables. In addition, CESEN (1986), the variation in the price of fuel overtime depends on a multitude factors such as: variation in the production and distribution costs of the existing energy sources, supply status, competitiveness of prices in relation with other substitute fuels, social characteristics and income level of the users.

In line with this, Balabanoff (1994) argued that the two most widely important factors determining energy demand are income and its rate of change. Energy consumption and its related costs may affect the path of economic growth, while it is also a function of growth.
He further stated that income elasticity of demand for energy in LDCs is larger than in industrialized countries, while price elasticity is smaller, due to the structural effects of development on the demand for oil and the availability of energy sources. Therefore, with a fall in economic growth, price increases may have a depressing effect on economies and reduce energy use. With higher economic activity, the demand for energy increases. On the other hand, a greater availability of energy may raise the level of production and generate higher income and employment. Many factors affect this relationship - for example, demographic factors, such as population and urbanization, the price of energy, the state of technology, the level of activity in the different economic sectors and environmental constraints.

Consistent with the above argument, Arimah (1994) examined the relation between energy and economic growth. Energy-economic growth relationship within a given country is a reflection of that country's level of economic growth. Similarly, commercial energy consumption per capita increases at a faster rate than per capita income, thereby resulting in an increasing value of the income elasticity of energy consumption. With high levels of economic growth, it is expected that commercial energy per capita will rise at a much slower rate than per capita income, thereby displaying a decline in the income elasticity of energy consumption.
Notwithstanding the fact that diesel demand is determined by the above major fundamentals of economic factors like price of diesel and income, diesel demand is not free from the influences of government regulation. For example, in most of the developing countries oil is imported and marketed by the government. This makes the consumer to use the oil

inefficiently which has a cross effect on the environment and the resource allocation of the country (World Bank, 1999). Not only the marketing by government makes the oil market in developing countries inefficient, but also the institutional framework and the transport system of these countries are weak. The institutions responsibilities for importing and price settings of oil are themselves inefficient. The price of oil is usually set above the cost due to the rent-seeking behaviour of governments (World Bank, 1999).

Based on the principles of markets, we can view the world oil market from two angles. These are the classical view (neoclassical view) and the Keynesian (neo-keynesian view).

The classical view naturally proposes that, like any other commodity, oil should be left to the forces of demand and supply. However, the problem with oil market is that the oil reserve is owned by few and hence the supply is monopolised in most cases. For instance, OPEC has about 70% crude oil reserve share and 40% average oil market share (Energy Information Administration, 1999).

The classical view, therefore, could not be a solution, as the oil market is very small and hence not competitive due to the monopolistic nature of the market as seen from the supply side.

The Keynesian view states that when the market becomes uncompetitive and persists, government (or some external force) should intervene in the market with the objective of removing the obstacles of the market. Particularly, the Keynesian view implies that the oil market should be intervened to decartelise it.

It is recognized that energy prices in many developing countries are fixed by the government, and do not reflect the real opportunity cost of using resources (in this case diesel). This suggests that the price level may not influence diesel consumption in the way the theory suggests.

2.3 Empirical Literature

Under this subsection, the study critically reviewed some empirical studies which have been used in analysing the demand for Gasoline and diesel. The biggest percentage of my review under this section is on gasoline and to a lesser extent diesel reason being that I was un able to access enough empirical literature on the demand for diesel however, these two are almost similar in their demand and usage. Most econometric demand models of gasoline and diesel are formulated by static and dynamic as well as by the above mentioned framework, which tend to be based on simple or multiple regression models where diesel and gasoline demand is a function of one or more independent variables.

The hypothesis that price of gasoline, income and vehicle stocks mainly determine gasoline demand, has been tested by several economists mainly in the context of developed countries. One such model (the simplest static model) was developed by Sterner and Dahl (1990) who analysed the demand for gasoline using yearly data for Sweden, and found that the mean long-run elasticities are 1.16 for income and -0.53 for price. These lower income and price elasticities prove the argument that less adjustment is captured much more easily, when the periodicity of data is shorter because it shows that, monthly or quarterly elasticities for the same model have an average of roughly half the yearly values.

Based on log-linear static model, the study on the demand for gasoline in the OECD countries was done by Sterner et al (1991) using time series data from 1960 to 1985. It was found that different models tend to give very different estimates, showing the need for careful model specification and interpretation of elasticities. Together with other studies, the analysis showed that average price elasticities range between -0.3 and -0.5. Income elasticities are, however, much more like the long-run estimates found by Baltagi and Griffin (1983). Cross-sectional data do, however, give much higher income elasticity values (around 1) for average OECD countries (Dahl and Sterner, 1991). This suggests that these data reflect adjustment to long-run changes in prices. However, a significant problem with the simple static model is that there may not be enough time for total adjustment to changes in prices and incomes within the unit time period of data.

Similarly, Rogat and Sterner (1997) used time series, cross-sections and pooled estimators to estimate gasoline demand in some Latin American countries on yearly data covered from 1960 to 1994. Individual country results in lagged endogenous model were found that the long-run price elasticities range from -0.16 to -1.71 with an average of -0.58 and the income elasticities ranging from 0.06 to 1.63 with an average of 0.64. Compared to the typical OECD results, those of the Latin American countries are somewhat lower particularly for income and show perhaps somewhat greater variability (See Dahl and Sterner, 1991).

The inter country results (cross sections between countries for various years) found that price elasticities were with in the range of -0.41 and -0.50 with an average of -3.1 and the income elasticities with in 0.99 and 1.23 with an average of 5.7. The cross sectional data give higher values for price elasticities in spite of the fact that we use a simple static model. This is because we capture the result of very low adaptation process when we compare between countries. As shown in Sterner (1991), however, the elasticities in cross-sectional estimates tend to be lower with smaller and more homogenous group of countries.

Moreover, the long-run elasticity pooled estimates for gasoline demand in some Latin American countries found that the price elasticities range from -0.5 in the pooled OLS to -0.8 in the cross-section. All were lower than the corresponding values for OECD which was shown by Franzen and Sterner (1995). There are two likely explanations. One plausible reason is lower flexibility to local prices since cars are not generally made to Latin American relative prices but to the relative prices in OECD or other car producing countries. Another reason would be that income elasticities should be high at lower income levels. It is in fact more difficult to say what the income elasticity is since estimates vary so greatly between models.

There are also few studies found in Latin American countries by different economists. Berndt and Botero (1985) found price and income elasticities for Mexico to be -0.33 and 1.41, respectively. These results were based on time-series data from 1960-79. Dunkerly and Hoch (1985), found price and income elasticities for Argentina to be -0.03 and 0.84 respectively, and for Chile -0.30 and 1.08, based on time-series data covering the period 1970-1981. Toto and Johnson (1983), found the corresponding elasticities for Venezuela to be -0.09 and 1.23 respectively. Both Dunkerly and Hoch (1985), and Toto and Johansson (1983), used basic static OLS method.

The econometric model discussed by Baltagi and Griffin (1983) on yearly data from 1960-1978 employed the static model to facilitate comparison among OECD countries and developing Asian countries. The individual country results for the OECD reported in Baltagi and Graffin (1983) showed that the short-run real price elasticities ranged from -0.04 to -0.79 with an average of -0.28 and short-run GDP per capita elasticities ranging from 0.11 to 1.14 with an average of 0.58. It was also found that the average GDP elasticity for the OECD countries was only about 50% of that for the developing Asian countries.

Pooling the analysis for OECD countries together, Baltagi and Graffin (1983) reported the following elasticities for the static model: a price elasticity of -0.32 and income elasticity of 0.66, and vehicle per capita elasticity of 0.64.

When the countries were grouped into - low and medium income, the income elasticities of the low-income countries were larger than the middle-income countries in the static model, but not in the dynamic model. However, price elasticities of the low-income countries were smaller (in absolute value) than the middle-income countries for both types of the models.

This is because; energy is a necessary ingredient in development so the low-income countries are less sensitive to price changes. The elasticity with respect to the number of vehicles per capita is lower (in absolute term) for the low-income countries, than the middle-income countries. This confirms the fact that low-income countries have fewer vehicles per capita and hence there is less spare capacity in the vehicle utilization.

When the study examined the dynamic model, Drollas L.P. (1984) estimated the lagged endogenous model using time series data on the OECD countries, the average long-run price elasticity found to be -0.80 and 1.31 for income. Similarly, vehicle and vehicle characteristic (efficiency) models capture short-run adjustment by inclusion of vehicle stock. The study done on OECD countries used the annual data by Drollas found that the average price elasticity and vehicle elasticities were -0.31 and 0.52, respectively. If these results are compared to simpler static model, they roughly imply that half of the annual adjustment comes through utilization or changes in vehicles characteristics, rather than changes in number of vehicles.

Charemza and Deadman (1992), using an Error Correction Model (ECM), showed that short and long-run price elasticities were -0.32 and -0.41 respectively, while short and long-run elasticities for vehicles per capita were 0.89 and 1.04, respectively. The estimates for the whole sample period depicted that the short-run elasticities do not differ much from the long run levels.

Bacon (1992) undertook a study on the possibility of whether fuel taxes can reduce air pollution cheaply through fuel substitution i.e. measuring the possibility of inter-fuel substitution. He found out that these depended on how flexible activities are with regard to fuel used.

Kimuyu P.K. (1996) analyzing the demand for diesel in Kenya used time series, estimated the long-run structural relationship between the demand for diesel and its arguments among which the trend factor was found insignificant. He also found insignificant long-run price elasticity of demand for diesel suggesting that a price policy is unlikely to influence the demand for diesel even in the long-run unless it is combined with other policies. The number of vehicles with current road licensing show the greatest elasticity followed by gross domestic product and proportion of people resident in Nairobi. Vehicle ownership and spatial population distribution therefore offer greatest policy potential regarding regulation of diesel consumption.

Employing an error correction model on the same estimation, he found that diesel demand, in contrast, was responsive to gross domestic product, to number of vehicles with current road licenses, and to the proportion of Kenya's residents in Nairobi. Diesel demand is, therefore, growth elastic and will continue to increase with income. The results further revealed insignificant price elasticity of diesel demand indicating that diesel taxes have only limited potential for regulating diesel utilization and in mitigating undesirable environmental consequences associated with rapidly increasing diesel consumption.

Studying on urbanization and consumption of petroleum products in Kenya, Kimuyu (1993) employed ordinary least squares on log-linear functions. He found that, the urbanization elasticities of the consumption of motor spirit and diesel, the two alternative fuels are slightly less than unity, indicating that an increase in urbanization, other factors remain constant, increases the consumption of these fuels by about the same proportion. The estimated gross domestic product elasticities ranged from 0.08 for motor spirit to 0.476 for diesel. The consumption process is, therefore, not GDP elastic.

Mureithi etal (1982) conducted a study to analyze the impact of increased energy costs on balance of payments, choice of production technology and real incomes in Kenya using time series data for the period 1964-1976. Their study revealed the existence of possibilities for substitution between different fuels and between energy and capital. They observed that most of the manufactured goods which Kenya imports use energy in their production. These products come from countries, which are equally affected by the international oil prices hence are highly priced. They contend that it is the direct costs of raw materials, rather than that of energy, which increased most rapidly over the period under study, suggesting that energy was not the major contributor of economic problems in Kenya. It is widely believed that oil crisis have been the cause of economic problems in Kenya.

To crown it all, the literature reveals that studies done in various countries have identified a multiplicity of factors determining the demand for gasoline and diesel. However, it is mostly determined by the level of income, price and vehicle stock. The most important findings were that the income elasticities of the low income countries were larger than the middle income countries; where as the price elasticities of the low income countries were smaller than middle income countries.

This study uses diesel demand models (and or to some extent gasoline where need be) synthesized from other models. But it differs from other studies by including additional explanatory variables in the models, namely, price of petroleum, population growth, foreign exchange earnings, level of inflation and the price of crude oil. Although demand for diesel is relevant for the assessment of the effects of new policy initiatives, to the best of my knowledge there is no enough information about empirical estimates for diesel demand undertaken in Uganda. Hence, this study is an attempt to fill the research gap.

2.4 THE CONCEPT OF TRADABLES

Salvatore (1995) defines tradable as the goods and services for which the pre trade price difference in the two nations exceeds the cost of transporting a good from one nation to the other. It can further be defined as goods whose prices are determined by the international market/ foreign market. According to Wikipedia (free on-line encyclopaedia), the word Tradable commodities refers to those goods and services for which there exist international markets.

JHINGAN M.L. (2007) has almost a similar view about tradable like that of Salvatore and he defines it as goods whose price difference between the countries before trade is more than the cost of transporting it between them. Transport here refers to all the costs that are incurred during the physical geographical movement of the goods and services. These may include things such as the cost of loading and offloading among others.

2.5 THE OIL INDUSTRY IN UGANDA

Oil is an important source of energy in Uganda. Heritage Oil and Gas ltd, of United Kingdom has completed a detailed seismic interpretation of Semuliki Basin (Turinawe Wilson (2003) the company is in the final stages of exploration in the different exploration areas near Lake Albert in Western Uganda. Uganda's petroleum resource in the Lake Albert basin is estimated to be over two billion barrels which is sufficient for commercial oil production for 30 years (Business vision (2010). It continues to explain that this petrol can generate over $2b every year. Uganda's downstream oil sector was liberalized in 1994**,** and price controls and bureaucratic resource allocation were abolished and a new petroleum supply act was promulgated in October 2003(EPRC 2009**)**. This led to the licensing of several companies, including several international oil companies like Shell, Total, and Caltex (now managed by Total) to take part in the industry. Although the sector is fairly competitive with even smaller firms operating, the market is dominated by the few international firms with the top three being Shell, Total and Caltex (Ministry of Mineral and Energy Development 2008). The country wet a head to put in place a policy to manage the sector. The Policy is the basis for progressively expanding investment in modern energy production, petroleum exploration and development, rural electrification, the supply of well priced petroleum products, and for increasing the efficiency of energy use in all sectors from the household consuming biomass for cooking to the big industries and the transport sector.

The Policy further focuses on:

- Developing positive linkages between the energy sector, poverty alleviation and economic growth;

- Integrating the objective of environmental sustainability into all energy initiatives;
- Demand side management and energy efficiency;
- Developing an energy resource base and dissemination of key information;
- Promoting private participation and the development of competitive markets in energy technology and services; and
- Developing, where necessary, appropriate regulatory frameworks and capacity.

2.6 KEY DETERMINANTS OF DEMAND FOR OIL PRODUCTS IN UGANDA

2.4.1 Number of Vehicles

The increase in the demand for both consumer and capital commodities which are basically not produced with in the country has led to increase in the level economic activities leading to increased demand for trucks to help in the transportation (importation) of such commodities. According to the 2006/07 Background to the Budget, Uganda's economic performance has continued to improve over the years by an average growth rate of 5.6 percent for the past decade. As a result, the number of vehicles on Uganda's roads has rapidly increased since 2000, accompanied by an increase in demand for Diesel. In 2007, Diesel which is solely consumed by Trucks accounted for 55 % in the same year. Other determinants include the level of urbanisation, price of crude oil, level of economic activities, price of diesel, taxes per litre of diesel, level of population, foreign exchange, level of inflation, Diesel powered generators among others.

Table: 2.1: Number of Tracks on Uganda's roads

Year	Number of Trucks in Uganda
2000	189105
2001	201520
2002	209278
2003	226191
2004	247045
2005	278594
2006	315903
2007	344334
2008	375324
2009	409104
2010	445923

Source: UBOS Statistical abstracts

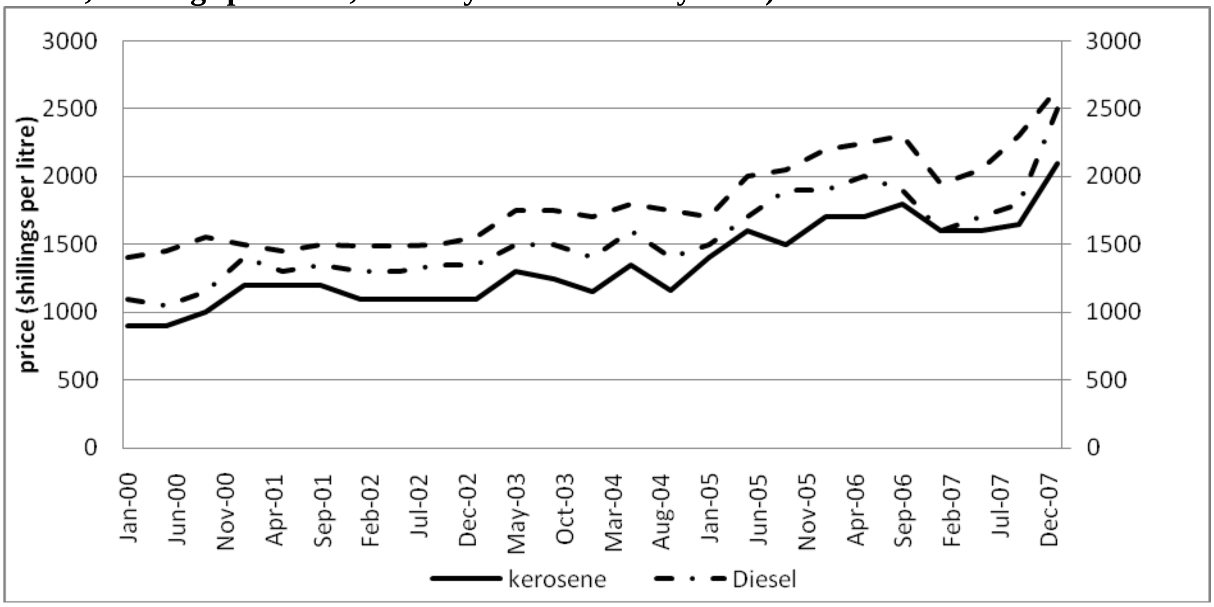
2.5: DIESSEL PRICE MOVEMENTS IN UGANDA

Uganda's fuel woes are closely linked to the recent power shortages that have increased the need for supplementary power to support the dwindling Hydro electric Power (HEP) from the two dams in the country. The recent prolonged drought in East Africa that reduced the water levels in lake Victoria which is the main source of water that generates electricity and the dilapidated power grid has caused a serious shortage of electricity, and this pressure on the power system prompted the government to encourage the entry of private firms to generate power from Diesel operated thermal generators and supply it to the national grid thus prompting the rise in the demand for Diesel and hence the price of Diesel.

But in spite of this, power supply has lagged the power needs of the country resulting in a load-shedding program introduced in February 2006, that has often involved cutting power off for more than 12 hours every day to all consumers except certain key installations (such as hospitals). As of the end of 2006 the hydroelectric dams with an installed capacity of 356 MW were operating at less than one-half of the capacity, with the power generated being supplemented by a 100 MW diesel-fired generators. This shortage is aggravated by the fact that some of the generated electricity is exported to neighbouring countries.

Although the amount of petroleum products being imported into the country have continued to increase, and the world crude prices to fall, local pump prices have continued to increase rising from Shs.1095 per litre of diesel in January 2000 to Shs.2,350 in May 2008. Petrol similarly rose from Shs1305 per litre to Shs.2650 during the same period.

Figure 2.1: **Average Pump Prices for Petroleum Products in Uganda (Kampala Pump Prices, Shillings per Litre, January 2000 - January 2008)**



Source: UBOS (2008)

2.6: Impact of high oil prices on GDP

There are two principal drivers of the demand for any product which include growth in demand and the price of the product. These two drivers can in turn be divided into four factors:

(i) The rate of growth of income;

(ii) The income elasticity of demand for the product;

(iii) The rate of increase of prices; and

(iv) The price elasticity of demand for the product.

Unfortunately, evidence on price and income elasticity in Uganda is sparse, partly because of lack of data, and tends to be based on data that is several years old. Although the GDP of a country is a generic measure of economic performance, it gives a fairly good indication of the magnitude of the impact of oil prices on the economy of a given group of countries. The second wave of exogenous shocks that hit most of the African economies in the early 90's and the subsequent world recessions, hurt the African states and particularly the non oil producers with Uganda inclusive in three ways (Deng 1998)

i) African states mainly the non oil producers found them selves paying more for their imports as a direct result of rising oil prices and most of the states were un able to curb down the rapidly growing domestic demand, particularly in view of the inelastic demand for imports.

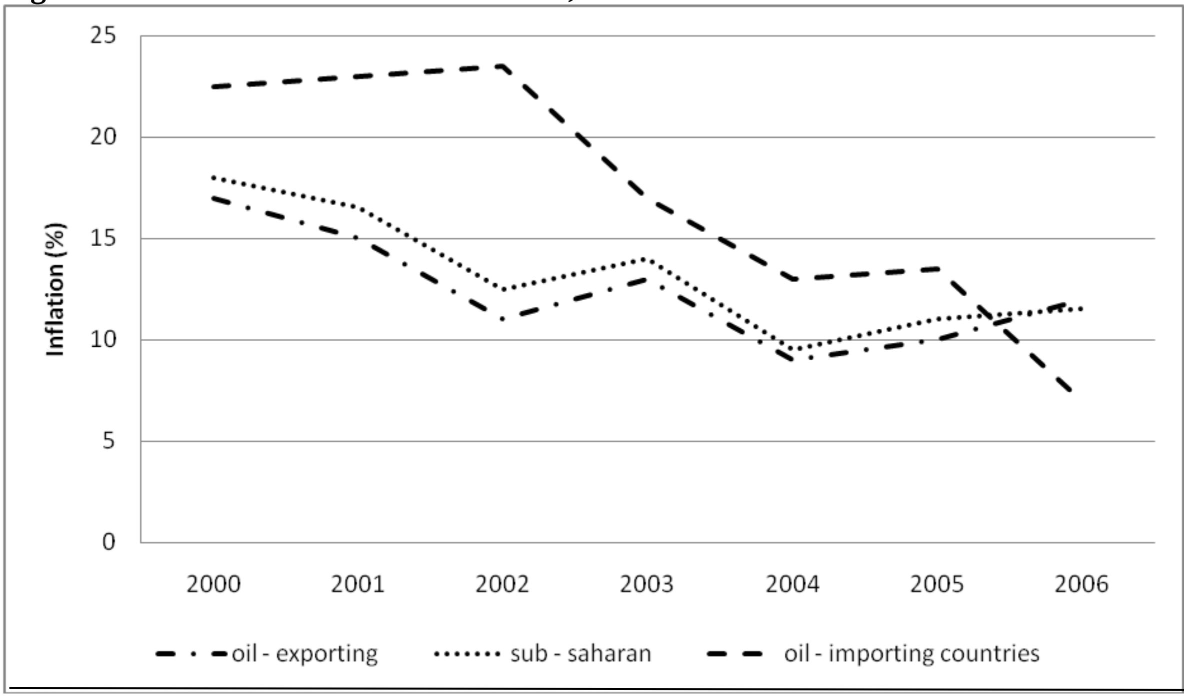
ii) Recession in the world economy led to the down turn in the demand for the primary products that Africa exported. Hence the ability of African economies to earn foreign exchange through non oil exports was greatly reduced.

iii) Given the rising cost of imports and falling foreign exchange earnings from exports, Africa economies should have adjusted, ceteris peribus, to reduce the BOP disequilibria. However, other things were not equal. Paradoxically, with easy access to foreign capital through the availability of petrodollars, Africa was lured into borrowing from various international sources such as commercial banks among others to finance the rising costs of imports.

2.6 Impact of High Oil Prices on Domestic Prices

In order to assess the real impact of high oil prices in African economies, it is important to understand that African economies are changing and significant improvements in terms of macroeconomic management are being reported, especially the very significant reduction in inflation (Figure 2.2). The key policy response to the impact of high oil prices is the extent to which governments have passed on the price increases to consumers, or have moderated them with subsidies, tax reductions, or pressure on oil companies to hold down prices.

Figure 2.2: Inflation in African Countries, 2000–2006

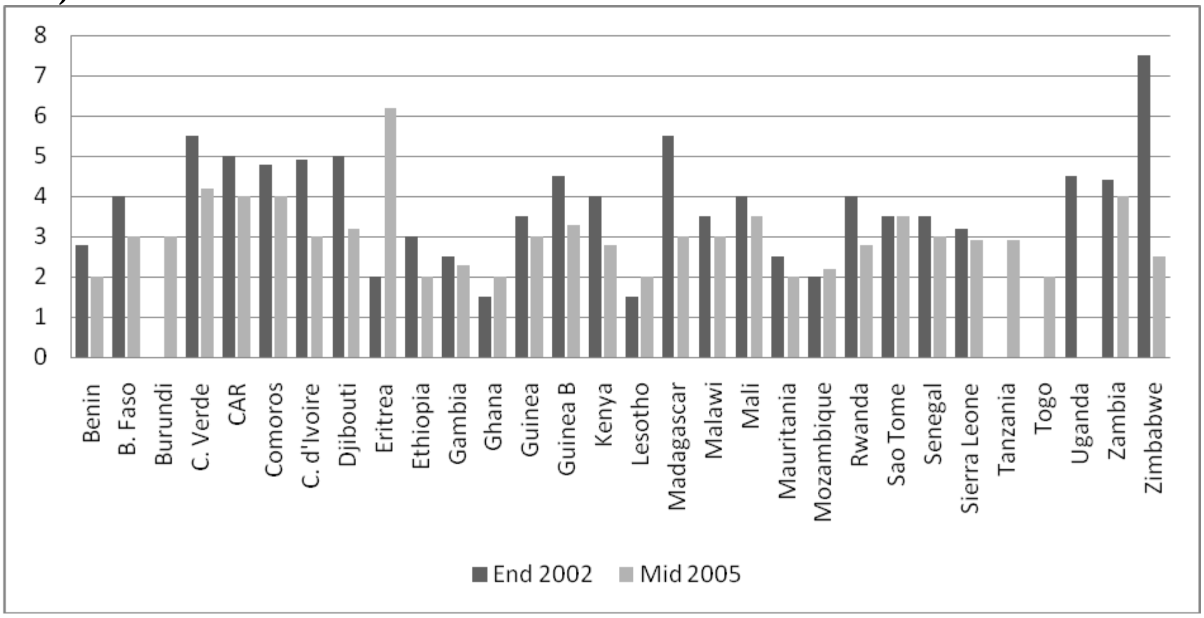


Source: IMF (2006).

In African economies where governments have been raising prices, and especially in those that have been passing on the full price increases to end users, it is expected that some reduction in the demand for oil will occur. Where domestic prices have not fully reflected international price movements, the demand for oil products tends to stay more floating, and the potential negative effects on the balance of payments and GDP are larger. A central issue in the adjustment of the economy to any price rise that has occurred is thus the magnitude of the price elasticity of demand for oil products (ESMAP, 2006).

The extent of pass-through can be observed in Figure 4.11. It has been high in most countries; partial in many countries; and complete in others. A special case is Eritrea, where the increase in domestic prices was eight times the change in the international price of oil.

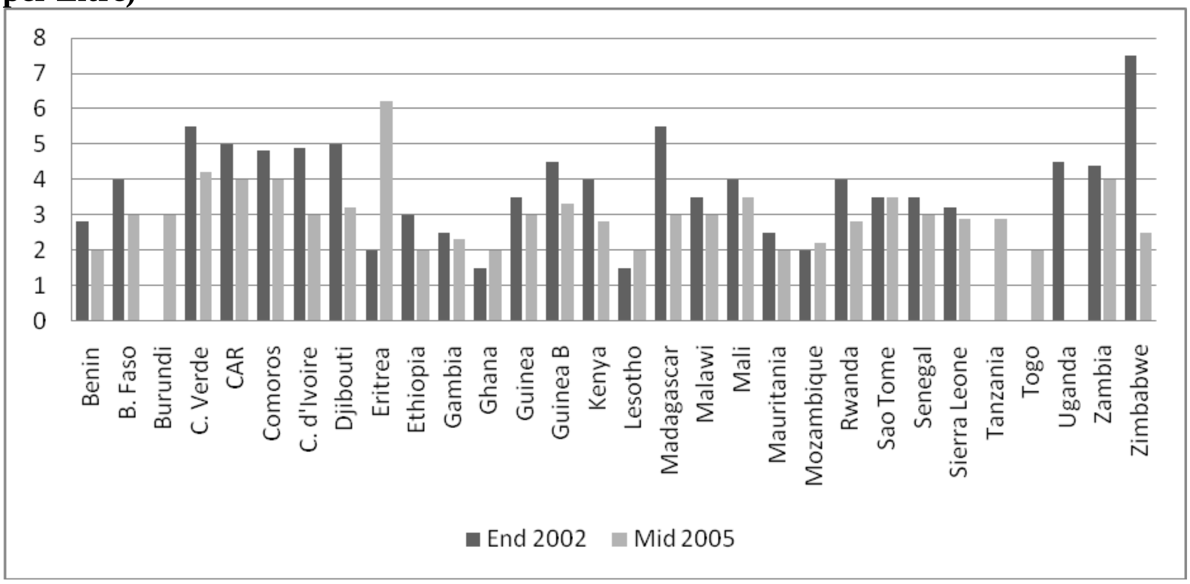
Figure 2.3: African oil product prices relative to crude oil prices (price in us cents per litre)



Source: IMF (2006); and AfDB Statistics Department Database (2007).

Substantially higher prices in recent years are illustrated in Figures 2.3 and 2.4 In fact, domestic Crude Oil US Retail prices in most African countries, which are among the poorest countries in the world, are higher than in the United States.

Figure 2.4: African Oil Product Prices Relative to US Retail Prices (Price in US Cents per Litre)



Source: IMF (2006); and AfDB Statistics Department Database (2007).

2.7 Social Impacts of High Oil Prices in Africa

In African countries, the social impacts of high oil prices are direct and most outrageous in the poorest communities, which do not have electricity and use kerosene for illumination. It is also well known that increases in the prices of commodities that feature prominently in the consumption basket of poor households have severe consequences on their living standards and well-being. In other words, higher oil prices worsen the incidence and depth of poverty and highly distort income distribution structures. For net oil exporters, higher oil prices are expected to be a blessing. However, key economic and social indicators for oil-exporting countries suggest that oil wealth has not been able to support sustained economic growth and development. Moreover, inequitable distribution of oil revenue among the population can fuel social tensions as has been witnessed in the case of the Niger Delta region and Sudan.

2.8 AFDB MODEL OF THE IMPACT OF HIGH OIL PRICES

2.8.1 Overview of the model

The Research Department at the African Development Bank (AfDB) has developed a model to quantify the impact of high oil prices on oil-importing and oil exporting African economies. The analysis is based on a dynamic stochastic general-equilibrium model of a small open economy. The model is rigorously "The Impact of High Oil Prices on African Economies," Working Paper Series (WPS) No. 93, December 2007, African Development Bank Group, Tunis Micro-founded in the sense that agents are fully optimising and form their expectations in a rational manner. This modelling approach has several advantages.

First, the inter-temporal nature of the model permits a study of the effects of transitory as well as persistent oil price shocks.

Second, because the time path of aggregate variables is determined by the optimising behaviour of economic agents, the model is robust to the Lucas critique, and, therefore, appropriate for policy analysis.

Third, this approach allows proper welfare analysis as it provides an explicit account of households' preferences.

Fourth, the general-equilibrium perspective ensures internal consistency and, more importantly, allows the study of the effect of oil prices without making arbitrary assumptions about what is exogenous and what is not.

Owing to these advantages, the proposed model supersedes existing naive data-based models, reduced form models, and static computable general-equilibrium (CGE) models. Data-based models are useful to characterize the statistical relationships between economic variables and to establish relevant stylised facts; however, these models lack economic content and do not reveal mechanisms through which shocks propagate.

Reduced-form models are often concise and easy to solve, but the aggregate relationships are usually not derived from first principles and the model parameters are not always invariant to shifts in policy regimes. The same criticism applies to CGE models, which, in addition, often ignore inter-temporal considerations. The proposed model belongs to the class of new open economy macroeconomic models, which have become the main tool used in modern international macroeconomics and are increasingly sought by international organizations and Central Banks around the world.

It is a state-of-the-art model that uses cutting-edge techniques to address positive and normative issues related to the effects of oil price shocks, but which can easily be extended to examine broader questions of relevance to the AFDB. The model is one of a small open economy and is adapted specifically to the context of oil and African economies. It is sufficiently flexible to represent virtually any African country.

In particular, it is configured to describe oil importers and oil exporters, credit constrained economies and those that have access to international financial markets, and countries with flexible, managed, and fixed exchange rate regimes. The economy consists of households, firms, a government, and a monetary authority. There are four types of goods: final goods, composite non-oil goods, oil, and intermediate goods.

2.8.3 Median Oil-Importing Economy

This economy is calibrated such that oil imports represent roughly 13 percent of total imports and 5 percent of total GDP in the steady state. Simulation results for this case are shown in Tables 4.2 and 4.3. The main conclusions are as follows:

Under fixed exchange rates and complete pass through, a doubling in the world price of oil leads to a decline in output and consumption, a slight increase in inflation, a small appreciation of the real exchange rate, and moderate changes in public and foreign borrowing. The output loss is about 6 percent during the first year, while the cumulative loss is about 24 percent during the five years following the shock. For consumption, the corresponding numbers are 5 and 19 percent, approximately.

Table 2.2: Effects of a 100% Increase in the Price of Oil
(Net Oil-Importing Country, Fixed Exchange Rate Regime)

	Impact effect (1 year)%	Cumulative effect (5 years)%
OUT PUT		
Complete pass – through	-6	-24
Zero pass – through	-1	-5
CONSUMPTION		
Complete pass – through	-5	-19
Zero pass – through	-6	-25
INVESTMENT		
Complete pass – through	-11	-39
Zero pass – through	-7	-25
INFLATION		

Complete pass – through Zero pass – through	2 -4	1 -4
REAL EXCHANGE RATE Complete pass – through Zero pass – through	-2 4	-7 22
BUDGET DEFICIT Complete pass – through Zero pass – through	4 31	7 45
FOREIGN DEBT Complete pass – through Zero pass – through	-1 9	2 11

Note: Budget deficit in percentage of steady – state out put.
Source: AfDB Statistics Department Database (2007).

The drop in output and consumption is attributed to a combination of two effects of high oil prices: a direct income effect, through the resource constraint, and a direct effect on production, through higher costs of inputs. The former decreases consumption and increases labour supply. The latter decreases demand for non-oil inputs and, by extension, demand for labour and capital. The net effect on

Table 2.3: Effects of a 100% Increase in the Price of Oil
(Net Oil-Importing Country, Fixed Exchange Rate Regime)

	Impact effect (1 year)%	Cumulative effect (5 years)%
OUT PUT Complete pass – through Zero pass – through	 -6 2	 -23 -1
CONSUMPTION Complete pass – through Zero pass – through	 -4 -5	 -18 -25
INVESTMENT Complete pass – through Zero pass – through	 -10 -1	 -38 -21
INFLATION Complete pass – through Zero pass – through	 5 4	 4 5
REAL EXCHANGE RATE Complete pass – through Zero pass – through	 -1 9	 -5 30
BUDGET DEFICIT Complete pass – through Zero pass – through	 0 6	 -1 20
FOREIGN DEBT Complete pass – through Zero pass – through	 1 16	 2 12

Note: Budget deficit in percentage of steady – state out put.
Source: AfDB Statistics Department Database (2007).

Hours worked is ambiguous, but labour income and investment unambiguously fall (due to lower marginal productivity of labour and capital). The resulting reduction in households' disposable income further decreases consumption and output.

The increase in inflation is due to the fact that the domestic price of oil enters the aggregate price index, and since there is complete pass-through, oil-price inflation contributes to core inflation. The higher inflation explains the appreciation of the real exchange rate (since the nominal exchange rate is fixed).

Under zero pass-through, the increase in the price of oil still leads to a decline in output and consumption, but the magnitude of the effects differs significantly compared with the complete pass-through case. The decline in output during the first year is less than 1 percent and the cumulative loss during the five years following the shock is roughly 5 percent. Hence, by choosing a zero pass-through, the government shields the production sector of the economy, thus minimizing the output loss. However, the cost of this intervention is a dramatic deterioration in the budget deficit (31 percent during the first year and 45 percent after five years), and, most importantly, a large decline in consumption, which drops by more than 6 percent during the first year and 25 percent after five years.

Under zero pass-through, there is a decrease in inflation, which translates into a real exchange rate depreciation of roughly 4 percent in the first year and 22 percent after five years.

Under a managed floating exchange rate regime, the nominal exchange rate is, to a certain extent, free to adjust, thereby acting as a shock absorber. In principle, therefore, the adverse effects of high oil prices should be less severe compared to the case with fixed exchange rates.

Under complete pass-through, however, there are only minor differences in the response of output, consumption, inflation, and to a lesser extent, foreign debt across the two regimes. The gain from letting the nominal exchange rate float is much more apparent under zero pass-through. For example, output initially increases by almost 2 percent (as opposed to a decline of 1 percent) following the rise in the price of oil, and the cumulative loss after five years is barely over 1 percent (as opposed to a loss of 5 percent). This smaller output loss is due to the larger depreciation of the real exchange rate relative to the case with pegged nominal exchange rates.

2.8.4 MEDIAN OIL-EXPORTING ECONOMY

This economy is calibrated such that oil exports represent roughly 88 percent of total exports and 35 percent of total GDP in the steady state. Simulation results for this case are shown in Tables 4.4 and 4.5. The main conclusions are the following:

Under fixed exchange rates and complete pass through, a doubling in the world price of oil leads to a 9 percent increase in output, a 42 percent increase in consumption, a 9 percent increase in inflation, a 6 The only notable difference across the two regimes is the response of the budget deficit, which deteriorates under the peg one, but slightly improves under managed floating.

Table 2.4: Effects of a 100% Increase in the Price of Oil
(Net Oil-Exporting Country, Fixed Exchange Rate Regime)

	Impact effect (1 year)%	Cumulative effect (5 years)%
OUT PUT		
Complete pass – through	9	53
Zero pass – through	10	56
CONSUMPTION		
Complete pass – through	42	152
Zero pass – through	41	149
INVESTMENT		
Complete pass – through	16	62
Zero pass – through	16	62
INFLATION		
Complete pass – through	9	15
Zero pass – through	6	14
REAL EXCHANGE RATE		
Complete pass – through	-9	-71
Zero pass – through	-7	-63
BUDGET DEFICIT	-114	
Complete pass – through	-108	-147
Zero pass – through		-139
FOREIGN DEBT		
Complete pass – through	-33	-47
Zero pass – through	-30	-45

Note: Budget deficit in percentage of steady – state out put.
Source: AfDB Statistics Department Database (2007).

9 percent real appreciation, a 114 percent reduction in the budget deficit, and a 33 percent reduction in foreign debt during the first year. The magnitudes of the cumulative effects after five years indicate that the adjustment of output, the real exchange rate, and foreign debt is non-monotonic.77 For example, the model predicts that the response of output to the 100 percent increase in the price of oil is hump-shaped, attaining its peak of 16 percent during the third year after the shock.

Table2.5: Effects of a 100% Increase in the Price of Oil
(Net Oil-Importing Country, Fixed Exchange Rate Regime)

	Impact effect (1 year)%	Cumulative effect (5 years)%
OUT PUT		
Complete pass – through	4	25
Zero pass – through	4	27
CONSUMPTION		
Complete pass – through	16	75
Zero pass – through	16	76
INVESTMENT		
Complete pass – through	3	22
Zero pass – through	4	23
INFLATION		
Complete pass – through	-13	-12
Zero pass – through	-14	-13
REAL EXCHANGE RATE		
Complete pass – through	-38	-136
Zero pass – through	-36	-130
BUDGET DEFICIT		
Complete pass – through	-7	-24
Zero pass – through	-6	-23
FOREIGN DEBT		
Complete pass – through	-55	-39
Zero pass – through	-53	-38

Note: Budget deficit in percentage of steady – state out put.
Source: AfDB Statistics Department Database (2007).

The increase in the price of oil generates a positive income effect, through the resource constraint, which increases consumption. This rise in consumption translates into higher demand for the final good, which more than offsets the negative effect of the

higher price of oil. As a result, the demand for oil and non-oil inputs increases (due to their complementarity), thereby raising the demand for labour and capital. The resulting increase in labour demand and investment further boosts the demand for the final good, and, therefore, output.

Under zero pass-through, there is a slightly larger increase in output, a lower inflation, and a smaller appreciation of the real exchange rate compared to the case with complete pass-through. However, this “gain” comes at the expense of a (marginally) smaller increase in consumption and a smaller improvement in the budget deficit.

Under managed floating, the output and consumption gains induced by the increase in the price of oil are smaller than under fixed exchange rates. This result is mainly due to the larger appreciation of the real exchange rate under the former regime. The smaller increase in consumption implies that the budget deficit narrows less than under the fixed exchange rate regime.

Under a managed float, the effects of an increase in the price of oil under complete and zero pass-through are strikingly similar. For the sake of comparison, Table 2.5 is generated with the same parameters as Table 2.4, except for the exchange rate regime. The deflation reported in Table 2.5 arises because the appreciation of the local currency makes imported goods cheaper. Reducing the share of imported goods in the economy and running the simulation over would give positive inflation.

In Uganda, the government imposes a fuel tax representing 50% and 44% of selling price of petrol and diesel respectively. On contrary, petroleum provided some 1/3 of government tax revenue in 1992/93. This has a direct bearing on petroleum prices (Turinawe Wilson (2003).

Kumar et al, (1991) noted that increases in prices of petroleum products results into severe strains on the importing developing countries. Correspondingly, Kumar further argues that decline in oil prices provide relief to the import capacity of these poor countries. However, Kabede, (1999) argues that the effects of price changes depend on the budget share of the fuels whose prices have been affected and house holds flexibility in relation to substitution between different fuel and between different energy and other consumption goods. The higher the budget share, the fewer the petroleum substitutes and hence the stronger the impact of price changes.

World Bank (1992) singles out subsidization of petroleum products as a major source of distortion in oil prices, leading to low cost and over use of petroleum products. On the contrary, most developing countries, especially oil-importing countries, impose tax on petroleum products that hikes petroleum costs and lowers the demand (World Bank, 1992).

According to the study carried out on the five major Asian countries (Ishinguro et.al 1995) outlines six characteristics of energy use in developing countries, which make them differ from demand patterns in more developed industrialised countries. Tasking Asia as a case in point, the pattern includes high energy consumption in industrial sector, rapid growth in demand for electricity, and low energy prices. These features are directly evident in Uganda's energy sector.

Empirical studies on commercial energy consumption reveals that the demand for petroleum products is price inelastic whereby a proportionate change in their prices leads to less than proportionate change in quantities demanded of petroleum products. This however, depends on the availability, and cost alternative sources of energy. Energy demand might decline when its prices rise, if consumers have alternative sources or simply because alternative sources of energy prove to be cheaper. To paraphrase this further, high energy prices of the 1970s led to a decline in petroleum demand as people as people shifted from petroleum products to cheaper sources of fuel energy. The drop in petroleum demand was also due to improvement in energy efficiency. As prices rose up, both domestic and industrial users started economising on the petroleum use, for example new automobiles were promoted and most countries imposed a ban on the importation of reconditioned vehicles of almost expiring models.

In analysing the factors determining the price of the selected petroleum products, the supply response of petroleum products is another important factor to consider. This is attributed to the fact that none of the fore mentioned upsurge in the oil prices has been due to high demand. However most of these have been driven by supply shocks of 1973-74 and

1997-1980 (Turinawe Wilson (2003) he further states that oil exporting countries have an upper hand in determining oil prices than demand considerations.

Russell and Lesser, (1998) noted that many governments are compelled to raise revenue through the regulation of fuel prices using a variety of mechanisms. The case in point is excise duty component of petrol in India is over 35.5 percent (Bhatia, 1991). Subsidies on petroleum products more especially kerosene is also characteristic of developing countries like Ethiopia and Sri Lanka.

From the preceding literature reviewed, its evident that once a consistent set of data is available on the prices of the selected petroleum products at refuelling stations in Uganda, its possible to understand why and how their prices varies and this time around keep on increasing overtime. The determination of price for the selected petroleum products is a prerequisite for understanding demand elasticities of these products to prices and incomes.
The literature reviewed also clearly indicates that no study has comprehensively brought to light the determinants of price for the selected petroleum products specifically to Uganda's case. Therefore, this study is after bridging the gap by attempting to identify the factors determining the price of the selected petroleum products in Uganda.

CHAPTER THREE:

METHODOLOGY AND ANALYTICAL FRAME WORK

3.0 Introduction

This chapter highlights the analytical frame work of the study, specifically it reviews the data type and data sources, data analysis using a simple econometric model, theoretical explanations for unit roots, co-integrated variables and tests, testing for long run relationships, error integration and error correlation model, model specification, explanations of the variables in the model and the limitations of the study.

3.1 The Data: Sources and Types

Prior to the estimation of the model, it is important to highlight the sources and types of the data used in the study. Accordingly, the study employed a time series data from different sources that covered the period from 1981 to 2010. This is basically secondary data which has been obtained from several sources. However the major ones have been the Uganda Bureau of Statistics (UBOS), which is a statistical department of the Ministry of Finance, Planning and Economic Development (MFPED). This is a state organ empowered by the constitution of Uganda under the statistics act of 1998 to carry out national house hold surveys. Other sources of information are the Uganda Revenue Authority (URA), World Bank, Bank of Uganda (BOU), International Monetary Fund (IMF), and African Development Bank (ADB).

This study has basically looked at the social-economic factors determining the demand of diesel in Uganda. These factors considered included; number of vehicles, price of diesel, price of petrol, availability of electricity, taxation, population growth, exchange rate, level of inflation as well as the price of crude oil. However, attention has been paid to these variables because they've been critically looked at as being the major determinants of demand for Diesel in Uganda over years and data availability has also been key in coming up with these factors. Diesel or ago demanded data is in barrels, the price of diesel is per litre of diesel demanded is in US$. The price of crude oil is in US $ per barrel. The population is as it appears in the national house hold survey based on the census range of thirty years. And the data on the foreign currency as well as inflation rate is in US$.

3.2 Model specification and estimation

Based on the reviewed literature and data obtained mainly from UBOS, the following variables were specifically considered to be the explanatory variables determining the demand for diesel in Uganda; price of diesel, the number of tracks, the price of crude oil, population size over the given period of time, the availability of electricity, foreign exchange, level of inflation, and price of petroleum.

3.2.1Diesel Demand Functions

As Hendry (1988) points out, there are no good reasons for accepting a partial adjustment model a priori excluding all lagged exogenous variables. Instead a much more general model should be a starting point which allows various lags on all variables.

The theoretical foundation of diesel demand model used in this study is based on the one developed by Sterner T. (1991), Sterner T. and Dahl C.(1991), Franz'en M.(1994), Franz'en M. and Sterner T. (1995), Baltagi B.H and Griffin J.m(1983); and Rogat and Sterner (1997). All of them agreed that, diesel demand (D) is a function of the price of diesel (P) and income (Y). Accordingly, the static models are used by Sterner and Dahl (1990) and Rogat and Sterner (1997) attempt to analyze the price and income elasticities of demand for diesel. The model considers diesel demand (D) as a function of the real price of Diesel (P) and real income (Y).

$D = f(P, Y)$.. (3.1)

The authors argued that two variables are the major determinants of diesel demand.

Similarly, Dahl and Sterner (1991) and Rogat and Sterner (1997) surveyed dynamic models specifically the partial adjustment type where diesel demand is also a function of its lag as shown below:

$D = f(P, Y, Dt_{-1})$.. (3.2)

Considering equation (3.2) above, the implication is that, prices and incomes have similar lag structures. If this assumption is relaxed, the result is a distributed lags dynamic of the general form. **$D = f(\_ Pt_{-i}, \_ Yt_{-i})$ ....(3.3)**

Dahl and Sterner (1992) modelled demand for transport fuel. They began by a simple static model which assumed that demand is homogeneous of degree zero in prices and income and deflected prices and income into real values which yields a log-linearity simple static model as:

$\ln D = C + \alpha \ln P + \beta \ln Y + \varepsilon$ .... (3.4)

Where, D is Diesel consumed, P is real price of Diesel, Y is real income and ε is random error term. To distinguish between the effects of a rise in GNP due to an increase in population, they took the number of people into consideration and came up with the equation below:

$\ln \left[\frac{D}{N}\right] = C + \alpha \ln P + \beta \ln \left[\frac{Y}{N}\right] + \varepsilon$ .... (3.5)

Franzen (1994) in his study also analyzed gasoline demand in OECD countries. His general gasoline demand function was:

$D_{ti} = \alpha + \sum_{i=0}^{r1} \beta i\, P_{t-l} + \sum_{i=0}^{r2} yi\, Y_{t-l} + \sigma V_t + \sum_{i=0}^{r3} \lambda i\, D_{t-i} + \varepsilon$.. (3.6)

Where, D_t = log (Diesel consumption per capita) at time t.

P_t = log (price of Diesel) at time t

Y_t = log (income (GDP) per capita) at time t

V_t = log (personal vehicle per capita) at time t.

ε = error term

r = degree of polynomial

The scholar's included vehicle stock affects Diesel consumption. I believe that this is an important variable which influenced Diesel demand especially in OECD countries. Baltagi and Griffin (1983) employed the static model to facilitate comparison among OECD countries and extended the coverage of the model to include different countries particularly the developing Asian countries. The model starts with the following identity:

Diesel demand = Distance per vehicle X Number of vehicles X$\frac{1}{efficiency}$ .... (3.7)

Where, Efficiency (E) equals Distance travelled per unit of Diesel.

Due to data limitations the application of such identity has been difficult. Thus the structure is usually normalized on a per vehicle basis, and the utilisation is hypothesised to depend on the real price of gasoline (Pago/Pagodp), real per capital income (Y/Npop) and the number of vehicles per capita (Nveh/Npop). Then the model is obtained as:

$$\left[\frac{\text{In Diesel}}{\text{Vehicle}}\right] = \alpha_0 + \alpha_1 \text{In}\left[\frac{Y}{NPOP}\right] + \alpha_2 \text{In}\left[\frac{\text{Pdiesel}}{\text{Ppagodp}}\right] + \alpha_3 \text{In}\left[\frac{\text{Nveh}}{\text{Npop}}\right] + \varepsilon \text{.................} \quad (3.8)$$

Other studies on the demand for diesel have involved variables such as vehicle characteristics and such models are referred to as vehicle characteristics model. They capture a long-run adjustment through the quantity and characteristics of vehicle stock, then the elasticities on income and price represent changes in utilization:

D = *f*(P, Y, V.CHAR) ....(3.9)

Where, V.CHAR is vehicle characteristics (vehicle efficiency)

In general, Pesaran and Smith (1995) acknowledge the fact that in principle the demand for any particular commodity is determined simultaneously by all other variables of the economy. The implication is that inclusion of additional explanatory variables will improve the realism of the model and its performance at least for forecasting. Therefore, to find a suitable dynamic model specification, the diesel demand equation can then be given in log-linear form as:

$$\mathbf{LDCPCt = \beta_0 + \beta_1 (LRPd)t + \beta_2 (LGHEP)t + \beta_3 (LRIPC)t + \beta_4 (LPG)t + \beta_5 (LNVDUC)t + \beta_6 (LRFEE)t + \beta_7 (LRPCOIL)t + \beta_8 (LLI)t + \varepsilon_t} \quad \text{...}(3.10)$$

Where by $\mathbf{LDCPCt} = \frac{log(total\ diesel\ consumption)}{log(ppn)}$

$$\mathbf{LRPd} = \frac{log(pxa)}{log(inf)}$$

$$\mathbf{LRIPC} = \frac{log(GDP)}{log(ppn)}$$

$$\mathbf{LRFEE} = \frac{log(ler)}{log(inf)}$$

$$\mathbf{LRPCOIL} = \frac{log(pcoil)}{log(inf)}$$

In Equation (3.10), $DCPC_t$ is Diesel consumption per capita; RPd is real price of diesel and; GHEP is Hydro Electric Power generated RIPC is real income per capita, PG is population growth, NVDUC is number of vehicles that use Diesel, RFEE is real foreign exchange earnings, RPCOIL is real price of crude oil, LLI is log level of inflation and ε_t is the error term.

In the literature review an attempt was made to give the variables which influence the demand for energy (gasoline and diesel) in the economy. A fall in consumption of diesel is likely to follow higher prices. It would also be expected that diesel consumption can increase due to growth in income (GDP), foreign exchange earnings, urbanization, population growth and stock of vehicles. Therefore, the set of relationships described in the literature review and model specification constitute the basis for the hypothesis to be tested in this study.

Generally, the anticipated signs of the coefficients will be $\boldsymbol{\beta}_1<0$, while $\boldsymbol{\beta}_2$, $\boldsymbol{\beta}_3$, $\boldsymbol{\beta}_4$, $\boldsymbol{\beta}_5$, $\boldsymbol{\beta}_6$ and $\boldsymbol{\beta}_7$ are > 0 for diesel demand.

3.2.2 Econometric Methodology

In dealing with time series data it is common practice to test the hypothesis that the process generating a series has a unit autoregressive (AR) root versus that this process is stationary (Leybourne and Newbold, 1999). If the variables are stationary, we can apply the Ordinary Least Square (OLS) method. If variables entering a regression are not stationary, then, results that are obtained using OLS techniques would be "Spurious".

Most macroeconomic variables are found to be non-stationary and show trending over time (Johansen, 1992). One can, however, difference or de-trend the variables in order to make them stationary.

If variables became stationary through differencing, they are in the class of difference stationary process. On the other hand, if they are de-trending; they are trend stationary. Most economic variables are, however, in the category of difference Stationary Process (Maddala, 1992). Such a procedure gives only the short-run dynamics while one's interest may be in determining the long-run parameters. In this study I apply the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests to detect the presence of unit roots in the data. Both the DF and the ADF tests are based on the null hypothesis that a unit root exists in the variables against the alternative that the variables are stationary.

The DF test is based on the following regression equations:

$$\Delta Yt = \boldsymbol{\beta}\ Yt\text{-}1 + \boldsymbol{\varepsilon}_t \quad (3.11)$$

$$\Delta Yt = \mathbf{a}_0 + \boldsymbol{\beta}\ yt\text{-}1 + \boldsymbol{\varepsilon}_t \quad (3.12)$$

$\Delta Yt = \mathbf{a}_0 + \boldsymbol{\beta}\ yt\text{-}1 + \mathbf{a}_2 t + \boldsymbol{\varepsilon}_t$ .... (3.13)

Equation (4.12) is a pure random walk model. Equation (4.13) adds a drift and Equation (4.14) includes both a drift and a time trend.

The ADF test is also based on these equations and augmented by the series of lags. The augmentation is required to tackle the possible autocorrelation problem. Therefore, the ADF has the following form:

$\Delta Y_t = a_0 + \alpha y_{t-1} + a_2 t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$ .... (3.14)

In the above equation both the intercept and a linear time trend are included and the augmentation is up to p lags. The unit root test requires that the null hypothesis a = 0 (there is a unit root) versus a < 0 (the series is stationary). In this case the usual t-test can not be relied upon instead we apply the ADF- test statistic (See Harris, 1995).

In order to obtain both the short-run dynamics and the long-run relationships, one can appeal to what is known as co-integration. The concept of co-integration implies that even if many economic variables are non-stationary, their linear combination may be stationary (Cuthberston, et al, 1992). If this holds, we say there is long-run relationship (co-integration) between the variables involved.

In testing for the existence of co-integration in time series data, the two widely employed methods are the Engle-Granger two step procedures and the Johansen maximum likelihood approach. In the Engle-Granger two-step procedure, variables entering the co-integrating vector are tested for integration of the same order; in fact order one – I (1). This procedure has its own weaknesses. In the first place, the residual that is used as error-correcting term in the second procedure is obtained from the static regression in the first step which is already suspected to be false. It also categorises variables as endogenous and exogenous with an implication of simultaneity problem. This implies that when there are more than two variables in the system, there can be more than one co-integrating vector and hence the Engle

Granger procedure does not give consistent estimates of any of the co-integrating vectors (Thomas, 1997). To this effect, the Johansen procedure is far superior to the residual-based Engle-Granger two-step procedure since (Masih, 2000; Harris, 1995):

i. Unlike the Engle-Granger procedure, it does not make a priori assumption about the existence of at most a single co-integrating vector; rather it explicitly tests for the existence of multiple co-integrating vectors.

ii. It is set up on a unified framework for estimating and testing co-integration relationships on the basis of the Vector Error Correction Mechanism (VECM) approach. The VECM contains information on both the short and long-run adjustments to changes in the variables in the model.

iii. It rests upon appropriate statistics for hypotheses testing for the number of co integrating vectors and test of restrictions upon the coefficients of the vectors.

Therefore, in this study, the Johansen maximum likelihood procedure to test for the existence of a co-integration vector(s) is applied. In the Johansen procedure, there is no priori categorization of variables as exogenous and endogenous. Hence, given Equation (3.10) it is possible to represent the variables by a vector Xt and the model as an unrestricted vector auto regression (VAR) with K lags (Johansen, 1995: 10, 45):

$$X_t = \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + - - - - - \Pi_k X_{t-k} + \Phi D_t + U_t \quad (3.15)$$

Where Xt is an (n x 1) vector of endogenous variables, Π_i is an (n x n) matrix of parameters, and Ut is independently and normally distributed with mean of null vector 0 and variances of Ω, i.e. Ut ~ IN (0, Ω). The deterministic terms Dt represent vectors of dummies and constants that are fixed and non-stochastic.

Equation (3.15) can be specified in Vector Error Correction Model (VECM) form as (See Hansen and Johansen, 1999):

$$\Delta X_t = \Gamma_1\Delta X_{t-1} + \Gamma_2\Delta X_{t-2} + \ldots + \Gamma_{k-1}\Delta X_{t-k+1} + \Phi D_t + \Pi X_{t-k} + U_t \quad (3.16)$$

Here, the estimates of Γ_i define the short-run adjustment, while Π contains the long-run information. D_t represents vectors of dummies, intercepts and predetermined exogenous variables. If the rank (r) of Π is zero, no stationary linear combination can be identified and hence the variables in X_t are not co-integrated. If Π has full rank, that is if r = n where n is the number of variables entering the co-integrating space, it implies that each variable is 'co-integrated' to itself, and hence each variable is I(0), which is in contradiction with the fact that the variables are I(1). The interesting case is, however, where Π has a reduced rank, that is, there are $r \leq (n-1)$ co-integration vectors present in β. Π may be decomposed into two matrices α and β, such that $\Pi = \alpha\beta'$, where α and β can both be reduced in dimension to (n x r). In this regards, β represents (n x r) vector of long-run parameters that makes $\beta' X_t$ stationary and the (n x r) α-martix constitutes the speed of adjustment to dis-equilibrium.

Hence, ΠX_{t-k} in Equation (3.15) is equivalent to $\alpha\beta' X_{t-k}$ and $\beta' X_{t-k}$ represents up to (n-1) linear combinations (co-integrating vectors) that ensure the convergence of the vector X_t to their long-run steady-state path (See Charemza and Deadman, 1997; Harris, 1995).

In the Johansen procedure there are two tests that help to identify the number of co-integrating vectors, called the trace (λ_{trace}) and the maximal (λ_{max}) statistics. These tests are given as follows (Harris, 1995):

$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\lambda_i)$

$\lambda_{max}(r, r+1) = -T \ln(1-\lambda_{r+1})$ r = 0,1,2, - - - , n-2, n-1.

Where λ_i=eigenvectors, T= number of observations and n is the number of variables.

The trace statistics is used to determine whether there are at most r co-integrating relationships while the maximal statistics tests the null hypothesis of r co-integrating vectors against the alternative of r+1. The magnitude of λ_i is a measure of the strength of the co-integration relations (denoted as $\beta'_i X_t$) are correlated with the stationary part of the model.

CHAPTER FOUR

DATA PRESENTATION, DISCUSSION AND INTERPRETATION OF THE FINDINGS

4.1 Introduction

This chapter presents, discusses, interprets the results and analyses them in line with the set objectives of the study. The primary objective of this study is to investigate the determinants of demand for diesel in Uganda. In addition it presents estimates of price elasticity of demand for diesel in Uganda using time series econometric techniques. The study also presents both short and long-run estimation for elasticities for the demand of diesel. The chapter first presents the unit root tests and proceeds to the results for the objectives of the study.

4.2 Unit Root Tests.

Regression of a non-stationary time series variable on another variable using the technique of Ordinary Least Squares (OLS) may result into spurious results and the simplest indicator is when R^2 value exceeds the Durbin Watson Statistic and this implies that there is no meaningful relationship between the variables. Therefore, it is recommended that Unit root test be carried out to test for the order of integration of the variables in order to avoid yielding such spurious results. A variable is said to be stationary if it's mean, variance and auto-covariance remains the same no matter at what point we measure them. The null hypothesis of non-stationarity is tested against alternative hypothesis of stationarity by employing the Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) tests. The study tested for the presence of unit root in all cases of trend and intercept or none. Found out that GDP variable were not stationary after first difference since its ADF statistics exceeded the critical values at 5% level of significance and was stationary after second difference. Original variables are provided in the appendix 3

Table 4.1: Unit root test results for variables in levels.

Variables	Critical value at 5%	Critical value at 1%	Computed ADF Statistics	Trend	Constant	I(d)
ACV	-1.9530	-2.6453	-5.192961	NO	NO	I(1)
ADPCT	-1.9530	-2.6453	-10.91536	NO	NO	I(1)
GDP	-1.9540	-2.6522	-6.931642	NO	NO	I(2)
HEP	-1.9530	-2.6453	-6.1109	NO	NO	I(1)
INF	-1.9535	-2.6486	-3.993974	NO	NO	I(1)
LER	-3.5943	-4.3552	-3.66622	YES	YES	I(1)
PCOIL	-1.9535	-2.6486	-7.528756	NO	NO	I(1)
PCY	-1.9540	-2.6522	-2.357890	YES	YES	I(1)
PPN	-2.9705	-3.6852	-4.391733	NO	YES	I(1)
PXA	-2.9798	-3.7076	-5.444274	NO	YES	I(1)
LRFEE	-1.9535	-2.6486	-6.807239	NO	NO	I(1)
RPD	-3.5731	-4.3082	-3.908999	YES	YES	I(1)
LRPXA	-3.5731	-4.3082	-3.661751	YES	YES	I(1)
TPA	-3.0038	-3.7667	-4.442280	NO	YES	I(1)

The series were differenced to make them stationary and the results are reported in table 4.1. They were stationary at their first difference at 5% levels of significance since their computed ADF values were less than their critical values at 5% level of significance. GDP was also stationary at 5% level of significance after second difference since its computed value was less than that of the critical value.

4.3 Determinants of demand of diesel in Uganda

The major objective of this study was to determine the determinants of demand for the amount of Diesel that is consumed. The study used ordinary least square to estimate a non linear regression model. The results from the study are presented in the table 4.2 and the factors identified from the model are discussed as below.

The results indicate that price is very significant factor in determining demand for diesel. A one percentage change in price will cause a 1.05846 percentage increase in quantity demanded. Also a one percentage decrease in price of diesel will cause 1.05846 percentage decreases in quantity demanded for diesel. This elasticity of demand is positive and is in contrary with the law of demand however, it supports giffen goods. The major cause of this could be that there is a high increase in the quantity of vehicles that are demanded and since these are complements, the effect of a high increase in the amount of vehicles purchased, out weighs the effect of price and the overall effect becomes positive.

The other important factor that determines demand of diesel with regard to the findings is the real exchange rate. The result from the study indicates that one percentage increase in the real exchange rate causes 0.01percentage decrease in quantity demanded. Also a 1 percentage decrease in the exchange rate will cause the amount demanded for diesel to increase by 0.01percent. This is true in the sense that diesel is imported out side the country and a negative elasticity implies that whenever exchange rate goes higher the purchasing power of the local currency becomes weaker and the price of diesel turn out to be expensive and there fore the demand has to come down. This result supports the law of demand which states that leaving other factors constant, the higher the price the lower the quantity demanded and the lower the price, the higher the quantity demanded.

Another factor that determines the amount of diesel demanded is per capita income. The coefficient on per capita income is negative implying that amount demanded and per capita income move in opposite direction. This is not expected in theory but the result indicates that a one percent increase in per capita income will cause 0.6 percent decrease in demand. Also a one percent decreases in per capita income causes 0.6 percent increase in the amount of diesel demanded. The major reason for this could be that whenever individuals' incomes increase, they may allocate their income to other economic goods since cars are taken to be luxuries to some people. Also per capita income may not be evenly distributed in the hands of many individuals and the cause of the increase in per capita income may be in the hands of very limited number of people and there fore such individuals even though their incomes increase they may already be having vehicles and cannot expand their consumption capacity for diesel that's why the result may be the way it is being observed.

The other determinant of demand is the number of diesel consuming vehicles. The results from the study indicate that the elasticity of demand of diesel coming from the diesel consuming vehicles is positive. One percent increase in the diesel consuming vehicles will cause a 0.18 percent increase in the amount of diesel demanded. Also one percent decrease in the number of diesel consuming vehicles will cause a 0.18 percent increase in the quantity of diesel demanded and this supports the theory of demand.

Lastly but not least, real price of diesel is also a factor that determines demand of diesel. The results indicate a positive elasticity of demand and one percent increase in price will cause 1.5 percent increase in the amount of diesel demanded. Also one percent decrease in real price of diesel will cause a 1.5 percent decrease in amount of diesel demanded. This may not always be the case in the sense that a general increase in prices will cause the real price of diesel to go down thus increasing the demand but the results don't support the theory.

Other variables such as real price of crude oil, generation of hydro electric power could not explain the model and the model has a higher explanatory power of 97.2% meaning that of the observed only 97.2% can be explained by the model. The remaining 2.8% cannot be explained by these observations.

The t statistics and their corresponding probabilities are provided in table 4.2. The criterion for choosing the level of significance was based on a maximum value of 0.1 probability level and there for any variable that had its value exceeding that was regarded to be insignificant in explaining the results.

Durbin Watson statistics was also used to test for the presence of serial correlation in the results. Since the Durbin Watson statistic is 1.7 this implies lower levels of correlation in the results and there fore a conclusion can be made based on such result. Due to non stationary of the time series data, the study found out those results were not spurious this was reflected in high values of Durbin Watson statistics.

The results obtained above are in agreement with Uganda's Electricity Regulation Authority (ERA), report for the key factors that determine the demand for petroleum products in developing countries and these include number of vehicles and level of economic activity and in contrary with hydro electric power supply which ERA found to be significant.

These results are also in agreement with Dahl and Sterner (1990), who identified the most important explanatory variables which were the level of economic activity and the relative price of gasoline.

LADPCT = 1.058457546*LPXA + 0.5015563785*LHEP - 0.6014514582*LRPCY + 0.1235883313*LINF - 0.0008838105802*LRFEE - 0.321302329*LRPCOIL - 0.09968415246*LPPN + 1.455965632*LRPD + 0.1789317993*LACV

Table 4.2 results for determinants of demand of diesel

Dependent Variable: LADPCT

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPXA	1.058458	0.383419	2.760574	0.0117
LHEP	0.501556	0.409588	1.224540	0.2343
LRPCY	-0.601451	0.200390	-3.001407	0.0068
LINF	0.123588	0.077709	1.590404	0.1267
LRFEE	-0.000884	0.000453	-1.949435	0.0647
LRPCOIL	-0.321302	0.277308	-1.158647	0.2596
LPPN	-0.099684	0.143208	-0.696078	0.4940
LRPD	1.455966	0.485251	3.000438	0.0068
LACV	0.178932	0.095370	1.876191	0.0746

R-squared	0.972333	Mean dependent var	11.92068
Adjusted R-squared	0.961793	S.D. dependent var	0.741115
S.E. of regression	0.144863	Akaike info criterion	-0.782736
Sum squared resid	0.440689	Schwarz criterion	-0.362377
Log likelihood	20.74105	F-statistic	92.25328
Durbin-Watson stat	1.73263	Prob(F-statistic)	0.000000

4.4Test for co integration

Due to the fact that regression of non stationary variable with other non stationary variables may yield meaningless results, the study tested for this possibility. When the over all outcomes are stationary it means that the results from the study are not spurious. In order to test for this, the study tested for the residuals obtained from the above models and the results indicated stationarity of the residuals implying that the variables are co integrated. Therefore the study proceeded to test for co integration test. The residual results are provided in table 4.3.

Table 4.3 stationarity of residuals

Variables	Critical value at 5%	Critical value at 1%	Computed ADF Statistics	Trend	constant	I(d)
Residual	-1.9530	-2.6453	-3.467520	NO	NO	I(0)

Due to the fact that the results were stationary, the study tested for the number of co integrating equations. In order to obtain the long run relationship between the variables that are influential in determining amount of diesel on all the observed variable that is price of diesel, real price of diesel, diesel consuming vehicles and exchange rate, the study used the Johansen co integration approach to test whether the variables mentioned above are co integrated. The study analysed these results from the Vector Autoregressive (VAR)/ Vector Error Correction (VEC) using the Variance Decomposition and Impulse Response Function. The results from the co integration test indicated a maximum of six co integrating equations. These results are present in table 4.4

Table 4.4 Results from co integration

Model selected	Linear	Deterministic trend		
	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.992318	336.2265	146.76	158.49	None **
0.879033	199.8995	114.90	124.75	At most 1 **
0.819224	140.7569	87.31	96.58	At most 2 **
0.714112	92.86303	62.99	70.05	At most 3 **
0.632118	57.80265	42.44	48.45	At most 4 **
0.492314	29.80287	25.32	30.45	At most 5 *
0.320567	10.82190	12.25	16.26	At most 6

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 6 co integrating equation(s) at 5% significance level

Where L.R is log likely hood test.

The model was selected basing on the minimum Schwartz criteria. Since the study indicated six co integrating equation Vector error correction model was used instead of vector auto regressive model. The study included the lagged error term for the residuals that were obtained from above in order to test for the speed of adjustment in the amount of diesel due to changes in these variables.

4.5 Effect of shocks to d(lrpd) d(lrpcy) d(lrfee) d(lacv) d(lpxa) d(ladpct). (Variance decomposition analysis)

Table 4.5 presents the variance decomposition for one type of ordering. The ordering presented below is d(lrpd) d(lrpcy) d(lrfee) d(lacv) d(lpxa) d(ladpct). This is of importance since it shows different responses of variables to any innovations or shocks. The study presents the results up to a period of ten years. A number of interesting features were observed from these results. In the first period shocks in real price of diesel 100% can be explained by its self and no response from other variables. However, in the subsequent periods less of it is explained by its self and other variables try to respond to such shocks. It can be noted that 49% of variation in prices is explained by its self in the tenth period and the remaining variables account for only 51%. Innovations in real per capita income only 99.8% can be explained by its self in the first period. However, less than 50% of variations in real per capita income can be explained by its self in the tenth period. It can also be noted that the response of demand to such shocks is only 10.8% in the tenth period which almost the same as 10.3% for shocks in the previous variable. Shocks in real foreign exchange rate only 97.4% can be explained by its self and only 44.7% in the tenth period and the response in demand is only 8.9% in the tenth period. Shocks in the supply of the number of diesel consuming vehicles can explain variations in consumption by 51.9%. Shocks in the foreign exchange rate can explain variations in diesel consumption by 40% in the first period and 20% in the tenth period. It can also be noted that 64% of changes in demand can be explained by changes in price for the previous shock in prices while the response in demand in the tenth period the response in demand will only be 6%. It can be noted that the major driver of demand is the change in the number of Diesel consuming vehicles followed by foreign exchange rate. Also these results are presented by figure 4.1 in the response functions.

Table 4.5 variance decomposition

Variance Decomposition of D(LRPD):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	1.887384	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
4	2.784849	58.53173	15.64363	7.327792	9.103616	2.404459	6.988775
7	2.981948	52.90683	14.99037	7.589761	9.990872	3.316504	11.20566
10	3.099341	49.14054	13.88830	8.170768	10.33553	3.710535	14.75434

Variance Decomposition of D(LRPCY):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	3.473328	99.78914	0.210858	0.000000	0.000000	0.000000	0.000000
4	5.165040	58.17576	16.11677	6.955169	9.558285	2.230530	6.963492
7	5.546728	52.34120	15.19371	7.372309	10.46391	3.209283	11.41959
10	5.772494	48.48671	14.05580	7.921952	10.80395	3.636406	15.09519

Variance Decomposition of D(LRFEE):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	396.6643	97.35104	2.132378	0.516584	0.000000	0.000000	0.000000
4	578.5513	54.47456	15.99920	10.71652	7.146652	3.421225	8.241835
7	621.3357	48.79277	15.15266	10.10543	8.437018	4.339274	13.17284
10	650.1863	44.71846	13.83842	10.70730	8.910770	4.712980	17.11207

Variance Decomposition of D(LACV):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	0.145980	0.093330	7.827386	40.13716	51.94213	0.000000	0.000000
4	0.289459	4.270362	2.857998	26.19142	25.95908	8.415759	32.30538
7	0.371021	3.271686	2.994639	19.61561	21.19686	9.573434	43.34778
10	0.434648	2.400046	2.765481	17.40535	19.96184	9.906493	47.56079

Variance Decomposition of D(LPXA):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	0.022264	29.15658	4.998655	0.428272	1.150880	64.26561	0.000000
4	0.038862	17.79675	46.91754	1.339981	3.354314	26.64719	3.944226
7	0.044102	14.58026	38.25608	7.029888	4.519640	22.76423	12.84990
10	0.047142	12.99485	35.37190	6.926328	6.041701	21.29437	17.37085

Variance Decomposition of D(LADPCT):

Period	S.E.	D(LRPD)	D(LRPCY)	D(LRFEE)	D(LACV)	D(LPXA)	D(LADPCT)
1	0.063574	0.911998	8.095222	11.42944	19.21499	0.751845	59.59651
4	0.090268	1.452559	11.33831	15.57109	12.89582	5.233032	53.50919
7	0.112246	1.235604	7.687664	14.16570	13.84762	7.190210	55.87320
10	0.130183	0.982878	6.487172	12.86725	14.30443	8.219636	57.13864

4.6 Impulse Response function Analysis

Impulse response functions are used to trace the effect of a one standard deviation shock to one of the innovations on current and future values of endogenous variables through the dynamic structure of vector error correction (VEC).

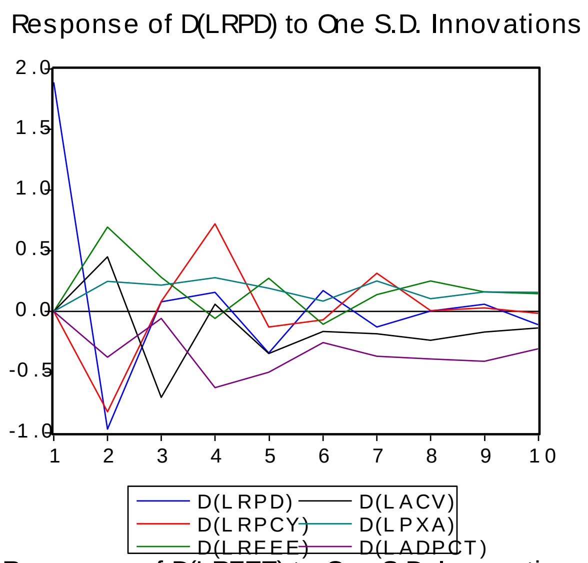
Shocks to any variable directly affect other variables or itself. Cholesky fractionalization approach is usually used to conduct impulse response analysis. In this case one should ask what shocks the amount of diesel demanded and how does it respond to different shocks.

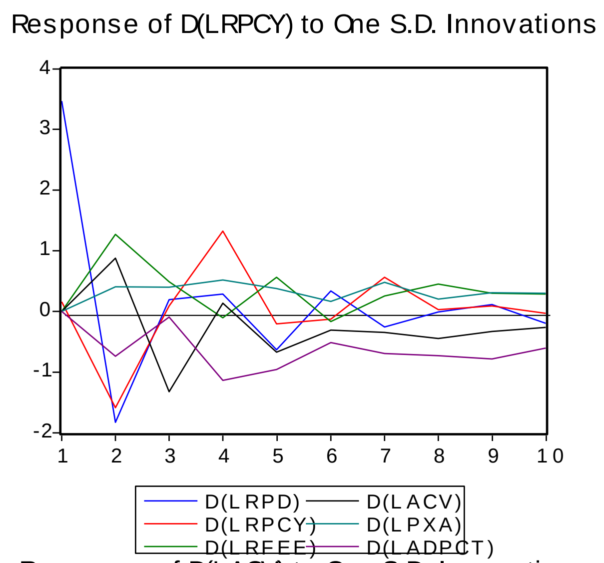
Fig 4.1 shows the graphical presentation of impulse response function showing how different variables respond to shocks in different time periods. It can be observed that a shock in real price of diesel bring in much variation in all other variable in the short run. However, in the long run some variables become stable and these include; real per capita consumption and real price of diesel.

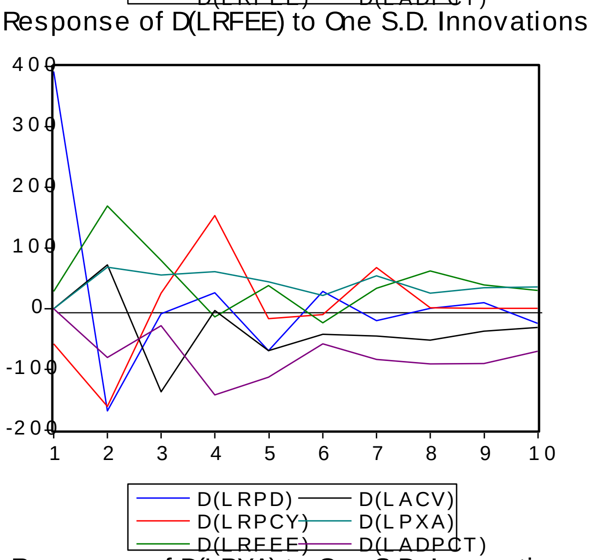
It can also be noted that shock in real per capita consumption brings some variations in the short run and these shocks diminishes in the long run thus, there is convergence in the long run. It can also be noted that shocks in real exchange rate causes a high variation in prices of diesel as compared to other variables. Any shocks that arise from demand causes high variation in other variables and there is no convergence even in the long run.

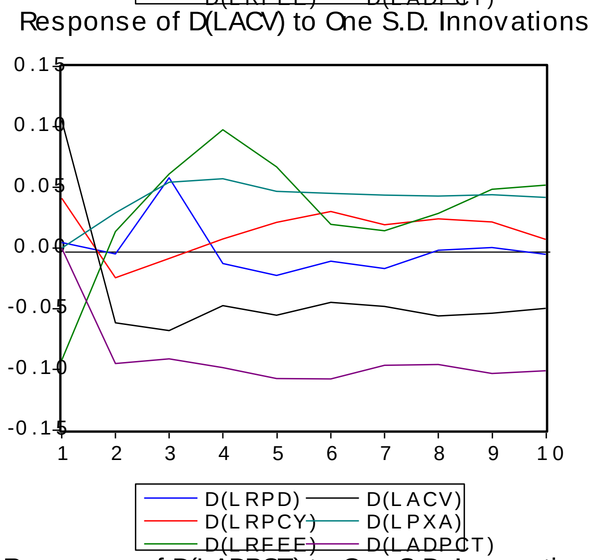
A shock in diesel consuming vehicles brings in variations in all other variables both in the short run and in the long run. These shocks do not show any convergence in any variable and therefore, such shocks will persist and continue to escalate prices and demand. It can also be noted that such a shock result into the greatest impact on its self. All these shocks have been traced up to a period of ten years forecast and these results are presented in figure 4.1

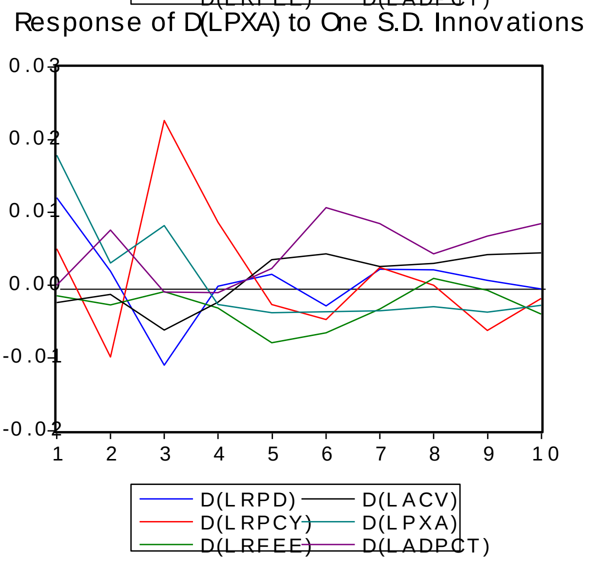
Figure 4.1: Impulse response functions

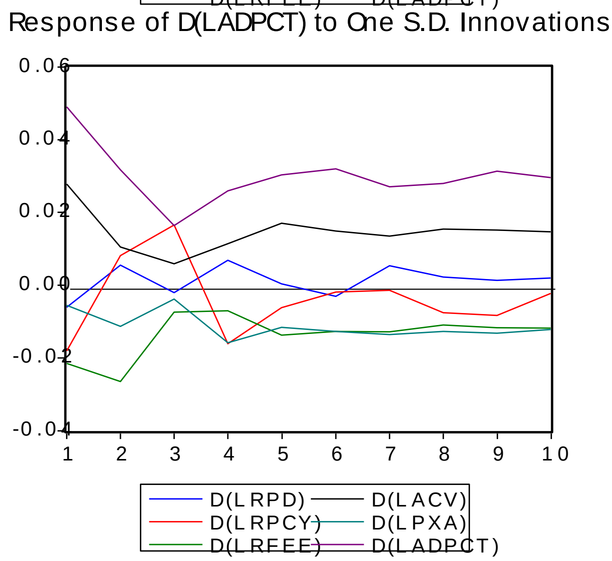












4.7 Short run determinants of demand for Diesel using ECM

Table 4.5 below shows short run determinants of diesel demand and the results from the study indicate that real price of diesel, real per capita income, foreign exchange are the major factors that derive consumption of diesel in the short run. And these are the same factors that accelerate demand in the long run. However, the numbers of vehicles are significant only in the long run.

The short run elasticity for per capita income is negative while that of price is positive. This explains why these results remain as earlier stated. The short run elasticity is 0.16 which is lower than the long run elasticity of 1.06 meaning that adjustments take long time to respond to given shocks. This also justifies the significance of the coefficient of the lagged error term. Also short run per capita income elasticity is lower in the short run in absolute terms which still magnifies the significance of the adjustment process for any given shocks.

These results are in contrary with Dunkerly and Hoch (1985), who found price and income elasticities for Argentina to be -0.03 and 0.84 respectively, and for Chile -0.30 and 1.08, based on time-series data covering the period 1970-1981. Toto and Johnson (1983), found the corresponding elasticities for Venezuela to be -0.09 and 1.23 respectively. Both Dunkerly and Hoch (1985), and Toto and Johansson (1983), based on OLS method.

Table 4.6 Error Correction Model (ECM)

Dependent Variable: D(LADPCT)

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(LRPD)	0.770679	0.354788	2.172224	0.0434
D(LRPCY)	-0.310698	0.138256	-2.247264	0.0374
D(LRFEE)	-0.000776	0.000399	-1.946018	0.0674
D(LACV)	0.080248	0.090206	0.889617	0.3854
D(LPXA)	0.156539	0.414756	0.377424	0.7103
D(LHEP)	-0.158577	0.298268	-0.531659	0.6015
D(LINF)	0.082176	0.058888	1.395452	0.1799
D(LPPN)	-0.887527	0.852871	-1.040635	0.3118
D(LRPCOIL)	-0.056075	0.124156	-0.451649	0.6569
R1(-1)	-0.364422	0.182665	-1.995036	0.0614
C	-0.125888	0.049861	-2.524783	0.0212

R-squared	0.490395	Mean dependent var	-0.088716
Adjusted R-squared	0.207281	S.D. dependent var	0.094146
S.E. of regression	0.083823	Akaike info criterion	-1.838532
Sum squared resid	0.126472	Schwarz criterion	-1.319903
Log likelihood	37.65872	F-statistic	1.732146
Durbin-Watson stat	1.801365	Prob(F-statistic)	0.149096

CHAPTER FIVE

CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions drawn from the above results on determinants of the demand for diesel and policy recommendations of the study and areas identified for further research.

5.2 Conclusions

This study investigated the major determinants of the demand for diesel in Uganda. The study used a double logarithm (transformed linear) model to investigate this issue together with a list of tools of analysis such as vectors error correction model; this uses the impulse response function and variance decomposition model to show the response of variables to shocks.

The study also investigated both short run and long run elasticities for per capital income and price. The results from the study identified only five major variables that were the major drivers of demand and these include; price of diesel, per capita income, number of diesel consuming vehicles, real foreign exchange rate and real price of diesel. These factors were responsible for high demand in the long run and in short run apart from the number of diesel consuming vehicles and price of diesel which were only significant in the long run.

The results from co integration revealed a maximum of only six co integrating equations and the error correction models showed time of adjustment of variables to given shocks. Real per capita income and real price of diesel could stabilize with given shocks in the long run as reflected on figure 4.1 above. The price elasticity of demand and income elasticity of demand were in contrary with expected signs.

5.3 Policy recommendations for the study

Basing on the results of this study, the recommendation is that much emphasis and planning should be put on mainly four variables to meet the over increasing demand for diesel to avoid insufficient supply of the required demand for diesel and these include price of diesel, exchange rate, number of diesel consuming vehicles and real price of diesel since any change in these variables will also cause changes in the required demand.

High consumption vehicles should be discouraged through high taxation so as to control on the demand and also ensure that there is a steady supply.

Studies, innovations and inventions should be done so as to invent vehicle engines that are powered by solar energy and electric power like the one that has been recently invented by the college of engineering Makerere University. This can work as an alternative to diesel powered engines hence checking on the demand for diesel.

5.4 Area for further research

This investigated the determinants of demand of diesel in Uganda and found contradicting results with per capita , elasticity of demand plus price elasticity of demand. Both of these were in contrary with the theory therefore future studies should try to investigate on the cause of contradiction in details.

References

Akiyama, T. Et al (1995), "Energy Demand in five major Asian Developing Countries", ***World Bank Discussion paper*** no. 277, World Bank, Washington, D.C.

Arimah B.C (1994), "Energy consumption and Economic growth in Africa: a cross national analysis" an energy and development forum, ***OPEC Review***, Vol. 18 No. 2 pp.207.

Archibald, Robert and Gillingham, Robert (1978), "Consumer Demand for Gasoline : Evidence from Household Diary Data," college of William and Mary and Bureau of labor statistics (mimeo).

Bacon, R., Et al (1992), “The Vulnerability of African Countries to Oil Price Shocks: Major Factors and Policy Options: The Case of Oil Importing Countries”, Energy Sector Management Assistance Programme (ESMAP), Balabanoff, S. (1994), "The dynamic of energy demand in Latin America", ***OPEC Review***, Vol. 18, No.4.

Baltagi, Badi H. Etal (1983), "Gasoline Demand in the OECD: An application of pooling and Testing procedures" ***European Economic Review*** 22(2) pp.117-137.

Baranes, C. et.al (1984), “Wood, Energy and Households”, The Beijer Institute, Stockholm, Sweden.

Botero, German (1985), "Energy Demand in the Transportation sector of Mexico," ***Journal of Development Economics***, 17, pp. 219-238.

CESEN Ansaldo / Finmeccaic Group (1986), co-ooperation agreement in Energy Sector, main Report.

Charemza, W.W. and Deadman, D.F. (1997), "New directions in Econometric Practice" Edward Elgar publishers, England.

Dahl, Carol A. Et al (1990), "The Pricing of and Demand for Gasoline. A survey of models" Memorandum 132, School of Ecnomics and legal science, Gothenburg University, February.

____________________ (1991), "A survey of Econometrics Gasoline demand Elasticities", ***International Journal of Energy Systems***, Vol. 11, No. 2

Evarest T. etal (2009) “ macro economic and welfare consequences of High energy prices EPRC Makerere university Kampala Uganda

Durkerley. J. Et al (1985), "Transport Energy Determinants and Policy" ***Resources for the Future***, Washington D.C.

Drollas, L.P. (1984), "The Demand for Gasoline: Further Evidence," ***Energy Economics*** 6(1) January, pp. 71-82.

Energy Information Administration (EIA), (1999). Official Energy Statistics from the US Government

Franz'en M. Et al (1995), "Long-run Demand Elasticities for Gasoline" ***Global Warming and Energy Demand*** ed, T.Barker P.Ekins and N.Johnston, Routledge, London.

Gately, D. Et al (1997), "The Demand for oil products in Developing countries" World Bank Discussion paper no. 359.

Hosier, R. et al., (1993), “Urban Energy and Environment in Africa”, Energy policy, Butteworth – Heineman, Vol. 21 No. 5 May 1993.

Hendry, David F. (1988), "The Encompassing Implications of Feedback versus Feed forward mechanisms in Econometrics ", ***Oxford Economic papers***, pp.132-149.

IMF (2006); and AfDB Statistics Department Database (2007).“The Impact of High Oil Prices on African Economies,” Working Paper Series (WPS) No. 93, December 2007, African Development Bank

http://en.wikipedia.org/wiki/Tradability

JHINGAN M.L. (2007)

Johansen, soren Et al (1983), "Testing weak Exogeneity and the order of co-integration," ***Journal of policy modeling***, pp.313-334, Reprinted in Ericsson and Irons

Kimuyu P.K. (1996), "Demand for Gas oil in Kenya, a Time series Analysis", IPAR, Nairobi, Kenya.

__________________ (1993), "Urbanization and Consumption of Petroleum Products in Kenya" ***Energy policy***, Vol. 21, No. 4

McRae, R. (1994) "Gasoline Demand in Developing Asian countries", ***Energy Journal***, 15:1 pp. 143-155.

Mureithi Et al (1982), "The effects of higher energy costs on balance of payments, employment, technology choice and real incomes in Kenya," ILO Report, Geneva.

OPEC review (1994), "Gasoline Demand in the OECD: Choice of model and Data Set in pooled Estimations" ***OPEC Review***, No. 155, Gothenburg.

Petrie D. (1961), *petroleum*. Oxford university press Amen house London

Pindyck R.S (1980), "The structure of world energy demand". M.I.T Press, Cambridge, mass. US.

Rogat .J Et al (1997), "The Determinants of Gasoline Demand in some Latin American countries" Studies in Environmental Economics and Development, Goteborg, Sweden.

Salvatore, D (1995), "*International Economics*". 5th Ed. New Jersey Prentice Hall Inc.: Englewood Cliffs,

Sterner Thomas (1991), "Gasoline Demand in the OECD: Choise of model and Data Set in pooled Estimations" ***OPEC Review***, No. 155, Gothenburg.

The Republic of Uganda, Ministry of Finance, Planning and Economic Development (1999), statistical abstract.

The republic of Uganda, Ministry of Finance Planning and Economic Development Uganda Bureau of Statistics (2001) Statistical Abstract

The Republic of Uganda, Uganda Revenue Authority (2003). Statistical abstract Uganda Printing and Publishing Corporation, Entebbe Uganda.

The Republic of Uganda, Ministry of Mineral and Energy Development, (2008), Statistical Abstract:

The republic of Uganda, Ministry of Finance Planning and Economic Development Uganda Bureau of Statistics (2008) Statistical Abstract

The Republic of Uganda, Ministry of Mineral and Energy Development, (2000), Statistical Abstract:

The republic of Uganda Ministry of Finance Planning and Economic Development Uganda Bureau of Statistics (2000) Statistical Abstract

Turinawe, Wilson (2003), Determinants of demand for petroleum products in Uganda Makerere University Kampala

Uganda Investment Authority (2000)"The Energy Sector" An investment profile on Uganda's private sector competitiveness project, Uganda Printing and Publishing Corporation, Entebbe Uganda.

UNDP/World Bank ESMAP, (1996)."Uganda: Issues and options in Energy sector, Report No. 8854-UG, July 1996" Joint UNDP/World Bank study pages 10-60.

Wohlgemuth, N (1997), "World transport energy demand modelling, Methodology and elasticities", ***Energy policy***, Vol. 25, No. 14-15.

World Bank (1992), Development and the Environment, the world development Report 1992, 1818H Street, Washington D.C, USA

World Bank (1999), "Energy Market & Reform", Seminar note, no.1

Appendix 1 Uganda; Locations of Micro, Small and Medium Hydropower Potential

Micro		
Site	**River**	**Estimated Capacity (MW)**
Arua	Anyau	0.3
Heissesero	Bunyonyi	0.3
Kitumba	Nyakabuguka	0.2
Mpanga	Mpanga	0.4
Nyakabale	Nyakabale	0.1
Moyo	Ataki	0.2
Kisiizi	Kissizi	0.2
Small		
Site	**River**	**Estimated Capacity (MW)**
Lake Bunyonyi	Bunyonyi	1.0
Nsongezi	Kagera	2.0

Paidha A	Nyagak	1.0
Paidha B	Nyagak	2.0
Ishasha A (West)	Ishasha	2.4
Ishasha B	Ishasha	3.6
Nyamabuye A	Kaku	1.5
Nyamabuye B	Kaku	0.7
Maziga Gorge	Maziba	0.5
Kaka	Ruimi	1.5
Mbarara	Muzizi	0.7
Sogahi A	Sogahi	2.7
Sogahi B	sogahi	3.3
Medium		
Site	**River**	**Estimated Capacity (MW)**
Muzizi	Muzizi	10
Bogoye	Mubuku	7.5
Nengo Bridge	Ntungu	12.0

Source: MEMD

Appendix 2 ANNUAL SALES FIGURES (M3)

	Premium	Kerosene	Gas Oil *	Aviation	Fuel Oil	LPG	TOTAL	Lubricants	Others
1979	78,865	48,501	56,647	6,477	56,561	695	247,746	8,026	
1980	114,360	58,336	85,558	16,660	26,638	804	302,356	7,252	
1981	62,055	28,165	55,105	19,304	21,415	649	186,693	5,576	
1982	58,387	35,258	58,410	22,317	17,702	300	192,374	3,900	
1983	63,358	39,100	67,100	22,300	23,600	500	215,958		
1984	77,166	39,100	71,000	19,000	15,400	500	222,166		
1985	87,461	43,600	75,700	21,700	11,700	500	240,661		
1986	96,381	43,189	79,959	22,736	13,357	508	256,130		
1987	101,540	41,022	85,818	30,000	18,200	850	277,430		
1988	112,566	43,544	97,464	21,653	15,310	779	291,316		
1989	123,673	47,220	108,672	31,946	13,156	562	325,229		
1990	120,408	42,360	101,271	16,796	14,868	488	296,191		
1991	109,512	34,562	92,672	17,546	12,809	567	267,668		
1992	107,752	29,409	85,108	17,721	13,039	632	253,661		

1993	115,595	29,463	83,207	35,186	15,698	663	279,812		
1994	139,437	33,453	99,626	42,780	16,212	693	332,201	40	
1995	166,048	43,068	120,395	31,556	24,566	1,005	386,638	4,430	
1996	181,777	46,361	124,348	42,241	29,468	1,420	425,615	5,969	
1997	177,044	48,576	125,621	44,643	34,124	1,629	431,637	6,832	
1998	191,977	59,508	149,529	60,708	39,384	1,977	503,083	5,507	
1999	202,626	60,684	179,717	50,772	42,340	2,200	543,465	5,127	
2000	190,462	56,163	187,276	40,212	36,087	3,082	513,282	5,127	
2001	200,021	55,539	207,236	43,915	38,591	2,892	548,194	5,127	
2002	203,533	91,027	195,366	40,270	32,391	3,116	565,703		
2003	155,173	40,697	220,096	66,974	41,889	3,805	528,635		
2004	186,285	49,340	260,978	79,131	53,313	4,500	633,547		
2005	174,054	39,836	319,574	88,932	44,423	4,488	671,307	6,805	68.6
2006	198,125	42,897	417,449	89,995	38,289	5,800	803,067	7,440	55.6
2007	191,713	34,309	464,122	92,616	34,384	7,273	824,416	8,493	79.8
2008	294,257	74,397	580,526	45,608	29,278	8,272	1,032,338	8,436	3606

Appendix3. Data for original variables used in the model

year	AdPCt	PXA (UShs)	ACV	PCOIL (UShs)	PPN	TPA (UShs)	HEP(MW)	LER (UShs)	INF (%)	GDP (UShs)
2010	721987	2277	411309	159975	31784600	530	2398	2025	16	25,768,903,130,813
2009	643623	2094	409104	125860	30661300	539	2307	2030	13	24,174,175,321,150
2008	580526	2035	375324	166840	29592600	521	2216	1720	12	22,579,447,511,487
2007	464122	2058	344334	122333	28581300	530	2125	1723	6	20,681,504,372,118
2006	417449	1886	315903	117184	27629300	530	2034	1831	7	19,138,224,938,562
2005	319574	1718	278594	94393	26741300	450	1857	1781	8	17,877,943,999,913
2004	260978	1501	247045	68780	25859700	400	1896	1810	4	16,251,581,383,442
2003	220096	1462	226191	56956	25089400	400	1768	1964	9	15,360,177,663,634
2002	195366	1270	209278	44950	24067200	400	1718	1798	3	14,469,048,489,727
2001	207236	1280	201520	42144	23310100	370	1593	1756	2	13,813,640,947,312
2000	187276	1196	189105	46032	22575400	370	1555	1644	2	12,991,660,475,675
1999	179717	1023	181347	26190	21863900	370	1342	1455	6	12,447,939,648,695
1998	149529	1023	130099	16120	21174700	370	1253	1240	3	11,684,691,907,050
1997	125621	1020	106665	20577	20507300	322	1218	1083	8	10,649,535,990,974
1996	124348	1010	155877	20920	19860900	304	1130	1046	7	10,113,411,848,786
1995	120395	1020	139473	16473	19235000	286	1057	969	7	9,520,801,597,347
1994	99626	1025	123069	15664	18628700	269	1018	979	10	8,703,393,216,592
1993	83207	1020	106665	20315	18041600	251	978	1195	2	7,854,797,890,284
1992	85105	1000	83231	21546	17473000	234	994	1134	31	7,337,004,548,770
1991	92672	1000	83231	13946	15959105	216	785	734	28	7,012,325,722,533
1990	101271	1004	59797	9867	15172504	199	738	429	33	6,646,393,653,414
1989	108672	1001	36363	4014	14385902	181	661	223	61	6,259,309,715,094
1988	97464	999	12930	1590	13599301	163	567	106	196	5,855,361,064,957
1987	85818	996	12928	774	12812699	146	619	43	200	5,431,068,133,765
1986	79959	994	12000	196	12026097	128	637	14	161	5,104,499,677,453
1985	75700	991	12000	189	11239496	111	626	7	158	5,028,050,102,780

1984	71000	989	12928	116	10452894	93	612	4	43	5,044,044,133,629
1983	67100	986	12928	120	9666293	76	513	4	24	5,288,336,392,982
1982	58410	984	10506	132	8879691	58	569	4	49	4,972,812,335,488
1981	55105	982	10506	140	8093089	40	517	4	109	4,613,296,806,555

Source: personal compilation from World bank statistics, UBOS, URA

NB. The price for crude oil (PCOIL) is per barrel.