IMPACT OF PETROLEUM CONSUMPTION ON ECONOMIC GROWTH IN KENYA

BY

WANJIKU EUNICE WAMBUI

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DECLARATION

This research paper is my original work and to the best of my knowledge has not been presented for examination in any other university.

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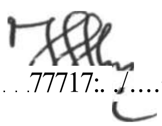
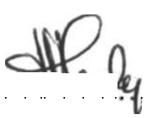
Candidate: Eunice Wambui Wanjiku

This research paper has been forwarded for examination with our approval as university supervisors.

Signature  ....Date

Dr. Omondi S. Gor

Signature  ....Date

Dr. Patrick O. Machyo

DEDICATION

I dedicate this work to my dear husband Jorum Kirubi, my son Remiel Ngunyi, Aunt Margaret Macharia, late mum and grand mum for your love and efforts in ensuring that I was always in school.

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ACKNOWLEDGEMENT

I would like to express my gratitude to my supervisors; Dr. Seth Omondi Gor and Dr. Patrick Machyo for their great kindness, helpful guidance, advice and recommendations in perfecting the study.

Special thanks to my dear husband Jorum Kirubi and our son Remiel Ngunyi for your patience and understanding when mum was away from home. Many thanks to my colleagues Simon, Samson, Patrick and Daniel for their support and encouragement as I worked on the paper. I am equally grateful to my classmates as they have been a source of inspiration, motivation and encouragement.

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LIST OF ABBREVIATIONS

ADF	- Augmented Dickey-Fuller
ARDL	- Autoregressive Distributed Lag
ECM	- Error Correction Model
FDI	- Foreign Direct Investment
GCC	- Gulf Cooperation Council
GDP	- Gross Domestic Product
GNP	-Gross National Product
GJ	- Giga Joule
GOK	-Government of Kenya
IEA	- International Economic Agency
NEMA	- National Environment Management Authority
PP	- Phillips - Perron
UNECA	- United Nations Economic Commission for Africa
VAR	- Vector Autoregressive Model
VECM	-Vector Error Correction Model

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ABSTRACT

This study sought to investigate the relationship between petroleum consumption and economic growth between 1980 and 2009 in Kenya. The amount of petroleum consumed was used as a proxy of energy infrastructure growth. In addition, other variables were hypothesized to affect economic growth including private physical capital and labor. The study employed co integration analysis and error correction methods to investigate the relationship. The analysis paid attention to the time-series properties of the data and the existence of long-run equilibrium between the variables. Granger causality tests were therefore carried out. The results of unit root tests indicate that all the series are integrated of order one, implying that the series are stationary after first-differencing. The co integration tests results indicate that the series are co integrated, implying that there is a long-run relationship between the variables in the model. The estimation results of the error-correction model indicate that petroleum consumption has positive short-run impact on real GDP. In addition, a deviation from long-run real GDP in a given year is corrected by about 18% in the subsequent year. The estimation results of the long-run model indicate that the output elasticity with respect to petroleum consumption is 0.017. Another result is that there is uni-directional Granger causality running from petroleum consumption to economic growth. Given the long-term positive effects on the economy the results suggested that an energy growth policy in the petroleum consumption should be adopted in such a way that it stimulates growth in the economy. Such growth would contribute to realization of vision 2030. Therefore, energy policy regarding petroleum consumption may be implemented in such a way that it further boosts economic growth as well as create investment opportunities in Kenya. On the other hand, the uni-directional causality between petroleum consumption and GDP implies that increase in petroleum consumption stimulate economic growth. Therefore, petroleum consumption may bc^x encouraged as it is beneficial to the economy of the country.

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CHAPTER ONE

INTRODUCTION

1.0 Background

Energy is one of the infrastructural enablers of the three pillars of the Kenya vision 2030.The level and intensity of commercial energy usage is a key indicator of socio-economic development in a country. Kenya is expected to use more energy on the road towards realization of vision 2030 goals. This is because as incomes increase and urbanization intensifies, household demand for energy is bound to rise.

Today, in the globalizing world, rapidly increasing demand for energy and dependency of countries on energy indicate that energy will be one of the biggest problems in the world in the next few decades. In this process, the search for alternative and renewable energy resources has become important for countries. Macroeconomic growth theories focus on labor and capital; they do not attach necessary importance to the role of energy, which is important for economic growth and production (Stern and Cleveland, 2004:7). However, today, energy is an indispensable production input for continuation of production process and indeed, there are a number of studies that have explicitly included energy in the production function.

Even though it is very well known that there is a strong correlation between growth and energy use, the issue of "causality" That is, whether economic growth leads to energy consumption or whether energy consumption is the engine of economic growth remains still to be answered (Sari etal. (2001); Konya (2004), (2004); Masih and Masih (1996)).This question has faced renewed interest given the increasing debate about the world climate changes as a consequence of greenhouse gas emissions. The motivation for examining the relations between income and energy consumption first arose in the 1970s when developed countries first proposed significant energy conservation programs. The underlying question then was to determine whether energy consumption caused economic activity (as measured by income) or vice versa.

The direction of causality, in fact, can assist the policy makers to take the most suitable decisions in climatic matters: for instance, evidence of unidirectional causality running from income to energy consumption could suppose the full compatibility between energy conservation policies and economic growth policies since the firsts can be pursued without limiting the seconds. On the opposite, the finding of unidirectional causality running from energy consumption to income may assume a particular significance with regard to the current debate about whether developing countries should be allowed to pollute more than the industrialized world, arguing that energy consumption could represent a stimulus for economic growth (Guttormsen 2004).

It is therefore useful to extend the previous research by employing the latest analytical tools on updated and broader data set, so that we may better understand these relations and the potential impact of proposed policies. In this study, the existence of the relationship between economic growth and petroleum consumption, which is a sub-component of energy consumption, will be researched. Co-integration relationship between variables will be examined with the recent bounds test approach developed by Pesaran et al (2001) and the short and long run relationships will be examined in the framework of the designed autoregressive distributed lag (ARDL) models. The study also intends to establish the direction of causality between energy consumption and economic growtfy^n Kenya.
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1.1 Energy Consumption and Economic Growth Profile in Kenya

Kenya is among the sub-Saharan African countries that are ranked lowest in per capita energy consumption levels in the world (United Nations Economic Commission of Africa, 2004). In the year 2001, Kenya was ranked number 169 out of 198 in per capita energy consumption worldwide. Energy is a necessity for survival and critical factor affecting economic development m Kenya (NEMA, 2005). Petroleum fuels are the major source used by commercial and industrial establishments. Electricity is the third source of energy in Kenya after wood and petroleum products, but is second to petroleum fuel as a source of commercial energy. About 80 Per cent of Kenya's population relies heavily on traditional energy sources such as biomass, agricultural residues, and other primitive energy sources, which exacerbate environmental degradation and air pollution related health impacts. The United Nations Economic Commission for Africa (UNECA, 2004) has cited the inadequate provision of modern energy services as a limiting factor in Economic growth and poverty alleviation.

Table 1: National Energy Consumption

"fype of Energy	Proportion of energy consumption(GJ Mill)	% of National Consumption
Biomass	530	76
Petroleum	150	21
Electricity	20	3
TOTAL	**700**	**100**

Source: *Household energy survey: kanfor 2002(corrected to 2011)*

At the national level, wood fuel and other biomass account for about 76% of the total primary energy consumption, followed by petroleum at 21%and electricity at 3%.

Table 2: Electricity Consumption, Petroleum Consumption and Real GDP Growth (%)

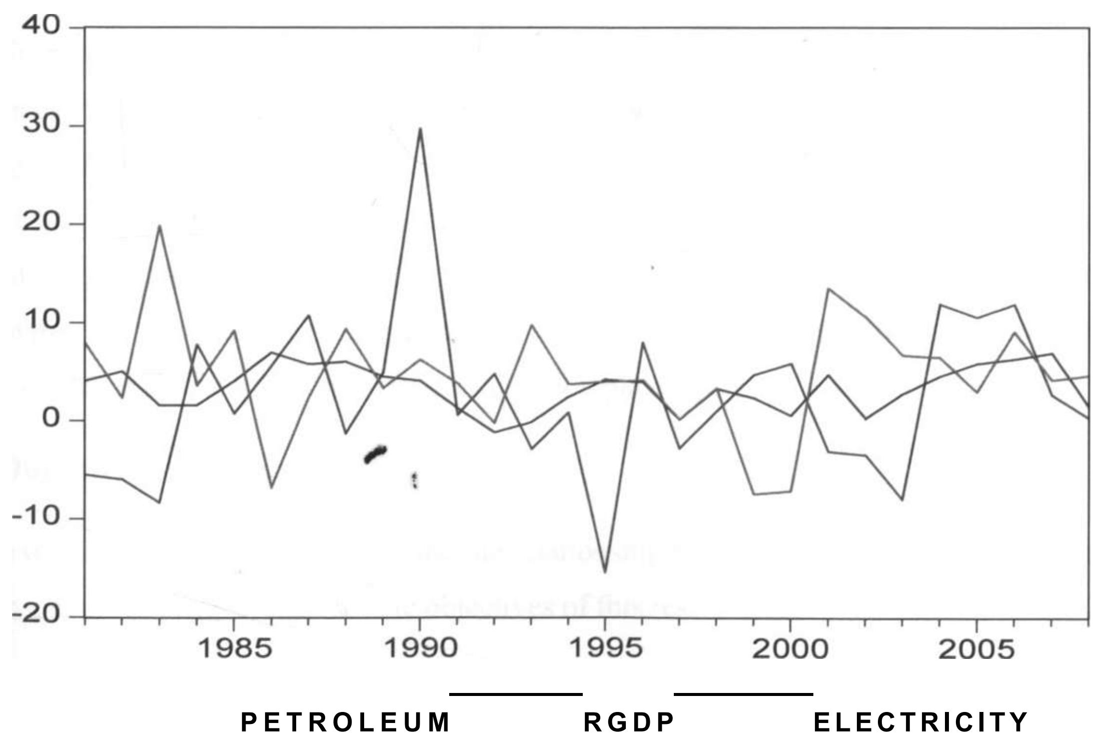
	1980-2008	80-84	85-89	90-94	95-99	00-04	05-08
Electricity	4.68	^ 8.46 t	3.54	4.74	0.90	6.08	5.23
Petroleum	2.40	-2.98	4.18	6.69	-0.86	0.69	6.40
Real GDP growth	3.38	3.09	5.50	1.37	2.85	2.61	5.18

Source: *Republic of Kenya (Economic Surveys 1980-2008)*

In Table 2, we see that the Kenyan economy has been subject to a 3.38 per cent annual real mcome growth rate for the 1980-2008 periods. However, there exist some fluctuations in the growth rates in some periods. The 1980s had an average of about 3 per cent or higher annual average growth rate, while the 1990s witnessed a substantial drop to the 1.36 per cent in the growth rates. There seems to be a revival in the real income growth rates for the post 2000 period.

It's evident that the 1980s and early 1990s had the largest growth rates in electricity and petroleum consumption and these average growth rates even exceeded real GDP growth rates indicating the pace of industrialization. Nevertheless, substantial drops in energy use growth rates occurred in mid and late 1990s. The post 2000 period saw both the energy consumption and real GDP grow gradually.

Figure 1: Annual Growth Rates for Electricity Consumption, Petroleum Consumption and Real GDP in Kenya for the Period 1980-2008.



Source: *Republic of Kenya (Economic Surveys 1980-2008)*

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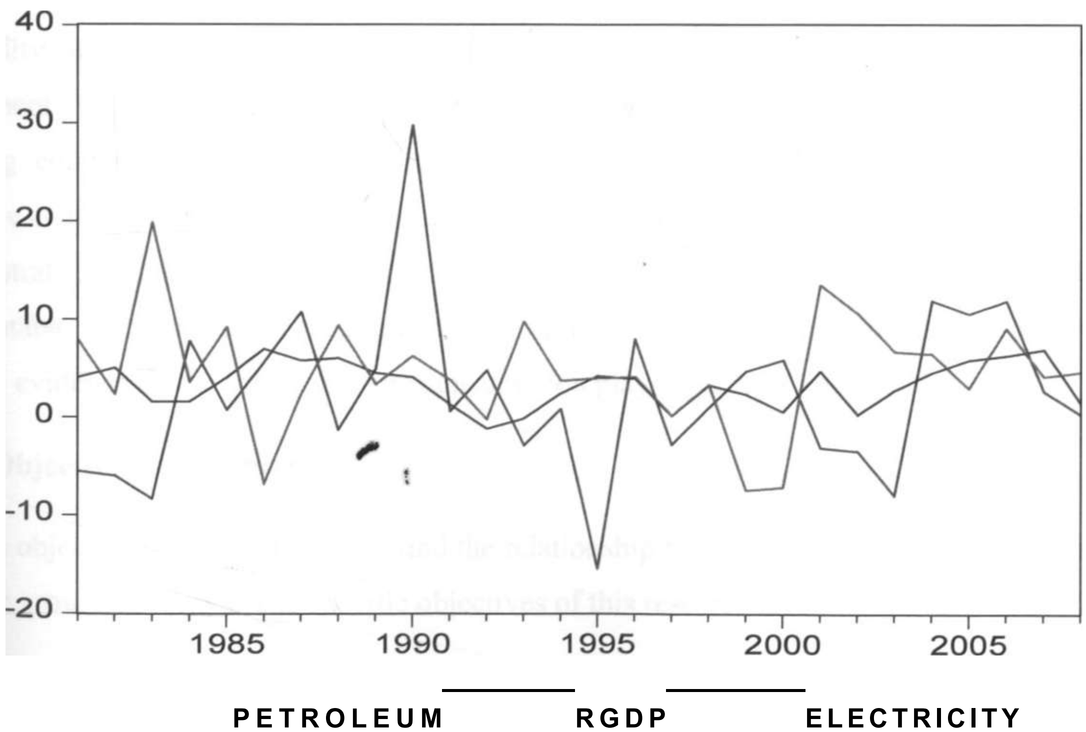

Source: *Republic of Kenya (Economic Surveys 1980-2008)*

As indicated in Figure 1, electricity and petroleum consumption grew in line with the economy over the last three decades.

1.2 Statement of the Problem

In order to become a newly industrialized, middle income country providing high quality of life to all citizens by year 2030, Kenya aims to achieve an average GDP growth rate of 10% per annum beginning the year 2012 (GOK,2007). However the current GDP growth rate of 5.6% is far from the desired growth rate of 10 percent by 2012.

Due to its prominent position in Kenya's industrial and commercial structure, petroleum is a major driver in the bid to increase GDP. This is because the country spends up to about *4%* of the GDP in the importation of petroleum products yearly (IEA 2000).

Ensuring increased provision of adequate, quality, reliable and affordable energy (petroleum) is bound to stimulate and support high economic growth. However the country is not secure in the supply of petroleum products since it depends on imported crude oil and refined products whose prices are erratic. The current policy objectives emphasize the need for the availability of energy, accessibility at cost effective prices and the supply to support sustainable socio-economic development while protecting and conserving the environment. Other strategies include increasing competition in the Petroleum sub-sector as well as encouraging and promoting alternative energy technologies to supplement the traditional source. In the implementation of the foresaid strategies there is need for policy makers to clearly understand what proportion of GDP is attributable to petroleum consumption. The aim of this study was therefore to provide empirical evidence on the role petroleum consumption plays in Kenya's economic growth.

1.3 Objectives of the study •

The main objective of the study was to find the relationship between petroleum consumption and economic growth in Kenya. The specific objectives of this research are:

i. To determine the short and long run relationship between petroleum consumption and economic growth.

ii. Examine Granger causality between consumption economic growth and petroleum consumption.

iii. To derive policy implications from the results regarding petroleum consumption and economic growth.

1.4 Significance of the Study.

The empirical study on impact of petroleum consumption on economic growth would be significant in several ways. The study will help investigate the linkage and causal direction between energy consumption and economic growth, which in turn will inform energy conservation and macroeconomic policies in Kenya. This is an important exercise for a small developing country like Kenya, which depends on energy imports to sustain its fast growth. The study will also add empirical evidence and test earlier suggested implications in the energy consumption-economic growth nexus.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

There has been a growing body of literature on the causal relationship between energy consumption and economic growth utilizing a variety of time series econometric techniques. This line of enquiry stems in part, from the earlier oil shocks of the 1970s to the more recent interest on energy prices and the impact of the Kyoto Protocol agreement by a number of industrialized and developing countries to conserve energy and to reduce greenhouse emissions. This chapter provides a brief survey of the theoretical and empirical literature on the causal relationship between energy consumption and economic growth. The chapter ends with a summary and overview of the literature reviewed.

2.1 Theoretical Literature

The relationship between energy consumption and economic growth and corresponding policy implications have been set forth in a number of testable hypotheses by researchers. The first hypothesis is that energy consumption is a prerequisite for economic growth given that energy is a direct input in the production process and an indirect input that complements labor and capital inputs (Ebbon, 1996; Toman and Jamelkova, 2003). In this case a unidirectional Granger causality running from energy consumption to GDP means that the country's economy is energy dependent, and that policies promoting energy consumption should be adopted to stimulate economic growth because inadequate provision of energy may limit economic growth.

The second hypothesis known as the "Conservation" hypothesis asserts that energy conservation policies such as reduction in greenhouse emissions, efficiency improvement measures, and demand management policies, designed to reduce energy consumption and waste may not adversely affect real GDP (Mehra, 2006).The "conservation" hypothesis is supported if an mcrease in GDP Granger-causes an increase in energy consumption. However, it is possible that a growing economy constrained by political, infrastructural, or mismanagement of resources could generate inefficiencies and the reduction in the demand for goods and services, including energy consumption. If such is the case, an increase in GDP may have a negative impact on energy consumption.

The third, "neutrality" hypothesis views energy consumption as a small component of real GDP and therefore energy consumption should not have a significant impact on economic growth (Asafu-Adaye, 2000; Jumbe, 2004). In this instance, energy conservation policies may not adversely impact real GDP. Support for the "neutrality" hypothesis is provided by the absence of Granger-causality between energy consumption and real GDP.

The fourth hypothesis assumes a bidirectional relationship between energy consumption and economic growth. This feedback hypothesis suggests that energy consumption and real GDP are interdependent and may serve as complements to one another. In this case, increases (decreases) in energy consumption result in increases (decreases) in real GDP, and likewise, increases (decreases) in real GDP result in increases (decreases) in energy consumption. In this case, the "feedback" hypothesis is supported by evidence of bi-directional granger-causality between energy consumption and real GDP.

2.2 Empirical Literature.

The relationship between energy consumption and economic growth has been widely discussed by many researchers around the world. Unfortunately, the empirical findings are inconsistent across countries including the maltiodology used.

Kraft and Kraft (1978) found a strong causality running unidirectionally from Gross National Product to energy consumption using annual data for United States of America for the period 1947 to 1974. They therefore argued, "while the level of economic activities may influence energy consumption, the level of gross energy consumption has no causal influence on economic activities". Akarca and Long (1980) using the Sims' technique for energy and Gross National Product contested Kraft and Kraft (1978) result; they used data for the United States for the period 1950-1968 and 1970 and found no causal relationship between Gross National Product and energy consumption.

Yu and Hwang (1984) confirmed the absence of any causality between energy consumption and Gross National Product over the sample period 1947 to 1979 for the United States. The same procedure revealed unidirectional causality running from Gross National Product to energy consumption over the sample period. Yu and Choi (1985) found different results for different economies. They found no causality between Gross National Product and energy consumption for the USA, UK and Poland. On the other hand, they found unidirectional causality from Gross National Product to energy consumption for South Korea and from energy consumption to Gross National Product in the Philippines.

Erol and Yu (1988) used Gross National Product and energy consumption for West Germany; 1952-1982, Italy; 1952 to 1982, Canada; 1952 to 1982, France and the UK; 1952 to 1982. They found bidirectional causality; for Japan, energy consumption causes gross national product for Canada, real gross national product causes energy consumption for West Germany and Italy and no causality was found for UK and France.

Nachane et al. (1988) using the Engle-Granger co-integration methodology, found long run relationship between energy consumption and economic growth for eleven developing countries and five developed countries. Using similar methodology, Glasure and Lee (1997) for South Korea and Singapore found bidirectional causality while Cheng and Lai (1997) found no long run relationship for Taiwan. Abosedra and Baghstain (1989) used direct Granger test and concluded that for all the periods 1947 to 1972, 1947 to 1974, 1947 to 1979 and 1947 to 1987, there was unidirectional causality beKve^n Gross National Product and economic growth.

Yu and Jin (1992) used employment data as a third variable in explaining the link between energy consumption and Gross National Product. They used monthly data over the period 1990-1994 for the United States and they did not find any evidence of co-integration. With this ^ysis, they concluded that energy restrictions do not harm economic growth in the United totes and that energy conservation has no clear impact on employment.

Masih and Masih (1996, 1997, and 1998) used the Johansen methodology to examine energy use and economic growth using several Asian economies. In Masih and Masih (1996), they found a long run energy income relationship for India, Pakistan and Indonesia but no long run relationship for Malaysia, Singapore and the Philippines. Masih and Masih (1997) used income, energy consumption and energy prices for Korea for the period 1955 to 1991 and for Taiwan for the period 1952 to 1992. They found bidirectional causality. On the other hand, Masih and Masih (1998) found a relationship but no evidence of directions for Thailand and Sri Lanka. Reddy and Yanagida (1998) considered energy consumption and economic activities in Fiji and concluded that total energy use in the commercial sector was sharply reduced as a result of structural changes in the economy and an increase in the efficiency of energy use.

Using gross domestic product and energy consumption with co-integration and Granger causality, Cheng (1999) for India used data for the period 1952 to 1995, Cheng and Wong (2001) for Singapore used data for the period 1975 to 1995; Aqeel and Butt (2001) for Pakistan used data for the period 1955 to 1996 and applied the technique of co-integration and Hsiao's version of Granger causality. They found that economic growth Granger causes energy consumption in their respective studies. Hwang and Gum (1992) found bidirectional causality while Cheng and Lee (1997) found no long run relationship for Taiwan. On the other hand, Yang (2000) used different types of energy consumption; oil, gas, coal and power to test for the causal link with gross domestic product in Taiwan. Using data for the periods 1954 to 1997, he found t unidirectional causality from economic growth to coal consumption and concluded that different forms of energy exhibited different direction of causality.

A slightly different set of studies from the ones discussed above are those of Ferguson et al. (2000) and Hannesson (2002). Ferguson et al. (2000) studied the relationship between electricity use and economic development in over one hundred countries. His general conclusion was that wealthy countries have stronger correlation between electricity use and wealth creation than there is between total energy use and wealth. The latter on his part took a more general view in which he considered increased energy use and economic growth in the later part of the 20th century. He found that energy use tended to grow more slowly than gross domestic product in nch countries while the reverse was the case for poor countries.

Glasure (2002) employed a five variable Vector Error Correction Methodology to study causality between economic growth and energy consumption in Korea. Government expenditure was used as a proxy for government activity, money supply was used as proxy for monetary policy and oil prices were included as important factor explaining the causality using data for the period 1961 to 1990. Structural breaks of two oil price spikes were further included as dummies in the model. He found bidirectional causality and the oil price was found to have the biggest impact on energy growth and energy consumption.

Soytas and Sari (2003) tested the time series properties of energy consumption and gross domestic product. They reexamined the causality relationship between the two series in the top ten emerging markets—excluding China due to lack of data and G-7 countries. They found bidirectional causality for Argentina and causality running from gross domestic product to energy consumption in Italy and Korea and from energy consumption to gross domestic product in Turkey, France, Germany and Japan. This implies that energy conservation may harm economic growth in the last four countries.

Oh and Lee (2004) also studied South Korea but shifted the data set ten years ahead to consider the period 1970-1999. They considered energy, labour and capital to be important production factors for generating gross domestic product. They used a Vector Error Correction methodology and found bi-directional causation. Squalli and Wilson (2006) study was a little bit different. They considered a bounds analysis^f electricity consumption and economic growth in the Cooperation Council for the Arab States of the Gulf. They tested the electricity consumption-income growth hypothesis for the six members of the GCC countries. Using the bounds test suggested by Pesaran et al. (2001) to test for long run relationship and the non—causality aPproach suggested by Toda and Yamamoto (1995), they found evidence of a long run relationship between electricity consumption and economic growth for all GCC countries. They also found support for the efficacy of energy conservation measures in five of the six countries with Qatar as the only exception.

Sica (2007) for Italy investigated the possibility of "energy demand-led growth" and "growth-driven energy demand" hypothesis using the error correction model. The result of the study did not reveal any causality linkage, though, the standard Granger test found evidence of unidirectional causality running from energy to gross domestic product.

Ighodaro and Ovenseri-Ogbomo (2008) for Nigeria used data for 1970 to 2003 on a co integration and bivariate Granger causality technique. They found unidirectional causality between energy consumption (electricity demand) and economic growth with causality running from energy consumption to economic growth. They concluded that a well-designed energy conservation policy can be an effective tool in managing the energy sector in Nigeria. Contrary to the result, Omotor (2008) also for Nigeria found a bidirectional relationship between coal production and economic growth as well as between economic growth and electricity use while Olusegun (2008) used a bound testing cointegration approach and found no causality between electricity consumption and economic growth. In a related, though, different study, Celik and Ozerkek (2009) examined the relationship between consumer confidence, personal consumption and other relevant economic and financial variables for nine European Union countries. Using panel data analysis, they found the existence of a long run relationship and concluded that consumers are able to detect early signals about future rates of economic growth as they contribute through the consumption channel.

Although literature is replete with studies on energy as a whole, there are studies that examine energy by separating it into its sub-components such as electricity and petroleum. Ghosh (2002) examined economic growth and electricity consumption of India between 1950 and 1997 and found a unidirectional causality from economic growth to electricity consumption. Jumbe (2004) examined the relationship between electricity consumption and GDP for Malawi for the period 1970 to 1999 and found a bidirectional causality relationship. However, when he examined the relationship between non-agriculture GDP and electricity consumption, he found a unidirectional causality from GDP to energy consumption.

Rufael (2006) examined the relationship between electricity consumption and GDP for 17 African countries for the period between 1971 and 2001 with limit test approach and found cointegration relationship in 9 countries and Granger causality relationship for 12 countries. While the direction of causality was from GDP to electricity consumption in 6 of these countries and from electricity consumption to GDP in 3 of them; bidirectional causality was found in 3 countries.

There are not many studies which investigate oil consumption and GNP interaction. Zou and Chau (2005) found no cointegration between oil consumption and GDP, in China for the period of 1953-2002. Due to liberalization of China's economy in 1984, they separate these periods into 1953-1984 and 1985-2002. They found cointegration relationship between oil consumption and GDP. In 1953-1984 periods, they found no causality between oil consumption and GDP in the short run; conversely, they found bidirectional causality in the long run. In 1985-2002 period; in short run they found unidirectional causality from oil consumption to GDP; however, in the long run there was bidirectional causality as in 1953-1984 period.

Jumbe (2004) studied the causality between electricity consumption, agriculture income and non agriculture income using an error correction model (ECM) and Granger causality analysis for the period 1970 to 1999 period in Malawi. The results showed that agriculture and non-agriculture income caused electricity consumption and at the same time the electricity consumption caused the total income. The ECM analysis results showed unidirectional causality from agriculture and non agriculture income to electricity consumption. Narayanand Smyth (2005) applied the same methodology as Jumbe (2004) to Australia and found that the growth affected electricity consumption and employment in the ^kiort run.
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Mozumder and Marathe (2007) used Granger causality to analyze causality direction between GDP and electricity consumption for Australia. He found that GDP affected electricity consumption but no causality was found from electricity consumption to GDP.

Asafu (2000) studied the causality between energy consumption, income and price for a number °f Asian developing countries such as India, Indonesia, Philippine and Thailand. He used Granger causality analysis data for the period 1971 to 1995. Results showed that the direction of ^usality were different for various countries in Asia. He found a unidirectional causality from energy consumption to income in India and Indonesia whereas a bidirectional causality between energy consumption and income was found in Philippine and Thailand.

Masih and Masih (2007) studied the causality between energy consumption and GDP in Asian countries using vector error correction model (VECM) and vector autoregressive (VAR) analysis. They used annual data over the period 1955 to 1999. They found no causality between energy consumption and GDP in Malaysia, Singapore and Philippine. They also found that there was bidirectional causality between energy consumption and GDP in Pakistan, unidirectional causality from energy consumption to GDP in India and unidirectional causality from GDP to energy consumption in Indonesia.

Ciarreta, et al. (2010) used panel data for European countries for the period 1970 to 2007 to analyze the causality between electricity consumption, real GDP and energy price. The causal relationship running from electricity consumption to GDP is revealed from their results. In addition, they find a bidirectional relationship between energy price and GDP.

Apergis et al. (2011) also used panel data for the period 1990 to 2006 for 88 countries. They found a bidirectional relationship between electricity consumption and growth in the short run and long run.

Chen et al. (2007) used electricity consumption data to test for a causal relationship with GDP in Asian countries. They used data for the period 1971 to 2001 to conclude that there was a unidirectional causality from GDP to electricity consumption in the short run in Malaysia. Furthermore, they found different results from Masih and Masih (2007) and Chandran (2010). They also found unidirectional causality from electricity consumption to GDP in Indonesia. The result in Philippine contradicted Masih and Masih (2007). However, they found a unidirectional causality from GDP to electricity consumption. Causality between electricity consumption and other variables in Malaysia was also found to contradict Lean et al. (2010) who found bidirectional causality between aggregate output and electricity consumption. Lang (2010) found bidirectional causality among total electricity consumption, industrial electricity consumption and real GDP in Taiwan for the period 1971-2006.

Yoo (2006) used different types of methodology (Granger causality) to test the causal relationship between electricity consumption and growth in Asian countries for 1971 to 2002 period. He found bidirectional causality between variables. This result is consistent with Tang (2009) who used a similar methodology using data for the period 1970 to 2005. Furthermore, he found unidirectional causality from growth to electricity consumption in Indonesia and Thailand, which is consistent with Masih and Masih (2007) results. Ho (2007) investigated the causality between electricity consumption and GDP in China. He used ECM analysis for 1966 to 2002 period and found unidirectional causality from electricity consumption to GDP. Shiu and Lam (2004) used the same method in China and obtained the same result.

Tang (2009) used ECM and Granger causality analysis to test for causality between electricity consumption, income, population and FDI. He used data for 1970 to 2005 period. He found bidirectional causality between electricity consumption, income and FDI in the short run. Chandran (2010) used ARDL analysis to test for causality on the same variables and found the same result.

2.3 Overview of Literature.

Understanding the impact of energy consumption on economic growth is an important consideration in the formulation of both energy and environmental policies. This survey of the literature on the relationship between energy consumption and economic growth has attempted to synthesize the results to date. Since the pioneering study of Kraft and Kraft (1978), the great amount of researches in this matter fmd evidence of unidirectional, bidirectional, or no causality according to the country studied. Furthermore, in some countries, different results occur for different time periods, leading to no definite conclusion. With regard to several empirical contributions, evidence of bidirectional relationship is established in the studies of Jumbe (2004) and Ghali and El-Sakka (2004) which examine Malawi and Canada respectively.

With the omission of the clear differences among countries in terms of structural and economic policy characteristics, the diversity of findings obtained depend upon the adopted variables and, *oove all, on the methodological approach used to test causality. Initially the causal relationship Was checked by using the standard Granger (1969) test and the Sims' (1972) approach. These two methodologies suppose that data series are stationary. As pointed out by Granger (1986), (1988), these tests do not permit us to find any long-run information between the variables, since they are only able to capture the short-run relationships. For this reason, the empirical findings of causal linkages based on these tests are often inconsistent. The current study thus attempts to analyze the relationship between energy consumption (petroleum) and GDP using the bounds test co integration approach (which is now considered as the most appropriate method for investigation of causality since it overcomes the problems depicted before) for a single country-Kenya.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Theoretical Framework.

The seminal work in the relationship between energy consumption and income is attributable to Kraft and Kraft (1978) who introduce their work with the following words:
"According to a current view, there is a constant and unchanging relationship between gross energy consumption and Gross National Product (GNP). A logical corollary is that energy conservation is an unacceptable policy option since it would adversely influence economic activity. This implies that the direction of causality runs from energy to GNP as well as the other way around

The source of the "current view" is never identified, and no theoretical model is specified for the relations between the variables. However, with the exception of the last seven words of the above quote, the implication is that the model underlying the "current view "was a production function model.

A general production function model relates economic activity (measured by output or income) to a set of economic variables with, at least, an implicit direction of causality flowing from these variables to economic activity. The analysis can be presented in the framework of a simple neoclassical production function. In this framework, it is assumed that output is determined by a Cobb-Douglas production function of the form;

$$Y_t = A_c L? \quad K^p{}_t \qquad (1)$$

Where Y_t is the aggregate output (GDP), A is efficiency of production at time t, L is labor, K is other physical capital of the country. A modified Cobb-Douglas production function can be used to analyse the relationship between petroleum consumption and economic growth. The modified production function can be expressed as follows;

$$r = A_t L? K_t^p P_t^Y \qquad (2)$$

Where Y_t is aggregate output (GDP), A_t is efficiency of production at time t, L_t is labor, K_t is other physical capital of the country, P_t is petroleum consumption, *t* denotes time (introduces possibility of technical change), a ,P and y are shares of L,K and P respectively. Expression of equation (1) in log linear form by taking the logarithmic transformation of the production function on both sides gives;

$$logY_t = log(A_t) + a\ logL_t + plogK_t + ylogP_t \quad (3)$$

The basic concept of growth implies periodical changes in output from periodical changes in inputs (Banister 2000) i.e. Y, A, L, K and P change over time.

3.2 Empirical Model Specification

The empirical counterpart of equation (2) can be written as:

$$\text{In } GDP_t = a_0 + a_x \text{ In } FPC_t \text{ -I- } a_2\ LnKPC_t + cc_3 lnxPC_t + £_t \quad (4)$$

Where:

InGDPt =Natural logarithm of GDP per capita

InLFPCt = Natural Logarithm of Labour force

InKPCt = Natural Logarithm of Private capital per Capita

InPCt = Natural Logarithm of Petroleum Consumption per Capita

ao, cii ,oi2 and 013 are parameters to be estimated and e_t is a random error term.

3.3 Econometric Analysis

Many macroeconomic time series are non-stationary and OLS regressions between such series are often spurious. However, while a single variable may be non-stationary, a linear combination of variables may be stationary. According to Granger (1988) such variables are co integrating t and a meaningful long-run relationship exists. Consequently, the estimation procedure with time series data must take this into account.

3.3.1 Testing for Unit Roots

The first step in analysing time series data was to determine whether they were stationary or not. This involved testing for unit roots to correctly test hypothesis concerning the relationship between two variables having unit roots i.e. integrated of at least order one. We tested therefore whether the time series are I (1) which is a necessary condition.The Augmented

Dickey Fuller (ADF) was used to test whether a time series was a stationary series or not. The ADF regression equation to test unit root in time series Y is written as:

$$\Delta Y_t = \alpha + \beta_1 y_{t-1} + \beta_2 T + \sum_{j=1}^{K} \gamma_j \Delta y_{t-j} + \varepsilon_t \quad (5)$$

Where y_t and Ay_t are the level and first difference of the relevant time series, T is the time trend variable, and a, Pi, p_2 and y are parameters to be estimated. The k lagged difference terms are added to remove serial correlation in the residual. e_t is the error term with zero mean and constant variance. Equation (4) is applied to each variable in equation (3).The null hypothesis is that HO: pi = 0 and the alternative hypothesis is that HI: pi < 0. If the computed ADF statistic is greater than the ADF critical value at a given level of significance, do not reject the null hypothesis, i.e., unit root exists and if computed ADF statistic is less than ADF critical value, reject the null hypothesis (unit root does not exist/series is stationary) in levels. If not stationary in levels, then all the series are differenced once to make them stationary. These series are therefore said to be integrated of order one, 1(1). In the case of the current study, the variables had unit roots (non stationary at levels) but became stationary upon first differencing.

3.3.2 Co integration Test

The variables in the current study were stationary on first differencing; hence, the next step was to determine whether there was a stable non-spurious (co integrated) relationship in level form. The Engle-Granger approach and/or Johansen Test of Co integration may be used to analyse the stationarity of residuals from levels regression. The current study used the Johansen Test of Co integration to establish the existence of a co integrating vector. In the long-run equilibrium, the error term e_t in equation (4) was zero. However, in any period the GDP per capita may deviate from the long-run equilibrium i.e. s_t is an equilibrium error. In this case;

$$^{\pounds}t = \text{In } GDP_t - a_0 - a_1 \text{ In } FPC_t - a_2\ LnKPC_t - a_3 lnxPC_t \quad (6)$$

The co integration test was based on the following regression equation:

$$e_t = 8_0 + \qquad + S_2\, T + \hat{} \; y\; j\; Ae_t\hat{} + u_t \quad \overset{m}{} \; \underset{>=o}{} \qquad (7)$$

Where e are the residuals from the co integrating regression (equation 4). The null hypothesis was Ho= $S_1 = 0$ and the alternative was H_0= < 0. Since we rejected the null hypothesis of unit root, we concluded that the variables in (equation 4) were co integrated of the order CI (1, 1).

3.3.3 Error Correction Model

Since a co integration in relationship I (1) was established, the error correction model (ECM) was estimated.ECM captured (i) short run dynamics that measured any dynamic adjustment between the first difference of the variables GDP-y and petroleum consumption -p and (ii) long run relationship that measured any relation between the level of the variables (y and p)

In order to examine the long run relationship between y_t and p_t, it was necessary to estimate the static model

$$y_t = p\, p_t + £_t \qquad (8)$$

From equation 8, Granger (1964) defined ECM as;

$$^8t = yt \text{ " } P\ Pt \qquad (9)$$

Where; p is a co integrating coefficient and e_t is the error from a regression of y_t on p_t.

The ECM was defined as;

$$Ay_t = a\, e_{t\_!} + yAp_t + \backslash i_t \overset{r}{} \; t \qquad (10)$$

Equation 10 implied that Ay_t can be explained by lagged value $€_{t\_1}$ and A p_t where $e_{t.x}$ is the equilibrium error (or disequilibrium term) that occurred in the previous period.e.g. if £t-i * 0, it means that y_t-i is too high above its equilibrium, so in order to restore equilibrium, Ay_t must be negative meaning that the error correction coefficient must be negative such that (equation 10) is dynamically stable. Since y_t-i is above its equilibrium, then it will start falling in the next period and the equilibrium error will be corrected in the model hence the term error correction model. Prom equation (9) and (10), P is the long run parameter while y and a are short run parameters.

$$e_t = 6_0 + S\hat{}t\hat{} + <S_2 7 + \sum_{j=o}^{m} Y y_; Ae_{t}\_! + u_t \qquad (7)$$

Where e are the residuals from the co integrating regression (equation 4). The null hypothesis was $H_0 = 8_1 = 0$ and the alternative was Ho= $S_1 < 0$. Since we rejected the null hypothesis of unit root, we concluded that the variables in (equation 4) were co integrated of the order CI (1, 1).

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$$yt = P Pt + £t \qquad (8)$$

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Equation 10 implied that Ay_t can be explained by lagged value e_{t_1} and A p_t where is the equilibrium error (or disequilibrium term) that occurred in the previous period.e.g. if $e_{t-1} > 0$, it means that y_t.i is too high above its equilibrium, so in order to restore equilibrium, Ay_t must be negative meaning that the error correction coefficient must be negative such that (equation 10) is dynamically stable. Since y_t-i is above its equilibrium, then it will start falling in the next period ^d the equilibrium error will be corrected in the model hence the term error correction model. Prom equation (9) and (10), p is the long run parameter while y and a are short run parameters.

The long run relationship was thus embedded in the error correction term 6_{t_x} and the short run behavior was partially captured by the error correction coefficient, a.

3.3.4 Granger Causality Test

Granger (1969) proposed a time series data based approach in order to determine causality. In the *Granger-sense* x is a cause of y if it is useful in forecasting y. In this framework "useful" means that x is able to increase the accuracy of the prediction of y with respect to a forecast, considering only past values of y. In this study we sought to test whether the disaggregate components of energy consumption (petroleum) "*Granger cause*" economic growth and vice versa.

A long-run relationship was established and therefore a test for Granger-causality was conducted to establish whether petroleum consumption contributes significantly to the explanation of the time path of GDP growth. Considering two time - series Y_t and X_t. A test for Granger causality aimed to find out whether Y_t predicts future values of X, and vice-versa. The unrestricted equations are expressed as follows;

$$Y_t = \beta_0 + \sum_{7=0}^{J} \beta_j \; Y_{t-j} + \sum_{k=0}^{K} \gamma_k \; X_{t-k} + \mu_t \qquad \textbf{(11)}$$

and

$$X_t = \alpha_0 + \sum_{j=1}^{;} \alpha_j \; X_{t-j} + \sum_{k=1}^{K} \beta_k \; Y_{t-k} + v_t \qquad (12)$$

Where: u_t and v_t are serially uncorrelated white noise residuals,

j, k are lag lengths for each variable,

a_0 ...a.j, p_0 . . . .Pk are parameters to be estimated

[i_t , v_t are random error terms

X_{t_k}, $Y_{t\_}j$ refers to lagged values of independent variables in equation (11)

$X_{t\_}j, Y_{t\_k}$ refers to lagged values of independent variables in equation (12)

In order to test for Granger causality, we verified whether the coefficients on X_{t-k} in equation (11) and coefficients on Y_{t-k} in equation (12) were statistically significant. The null hypothesis tested in equation (9) was that X does not Granger-cause Y. That is, H_0= Yo = Yi =……= Yk =0 and Y does not Granger-cause X (H_0= Po = Pi =……..= Pk =0)

3.4 Definition of Variables

In this study, secondary annual time series data covering the period 1980-2009 was used. All variables were expressed in natural logarithms.

Real Gross domestic product (GDP) per capita

This is the annual real GDP (Kshs) divided by labor force.

Private capital stock (KPC)

This refers to additions to the fixed assets of the economy plus net changes in the level of inventories-plants, machinery and equipment purchases (Kshs) divided by labor force.

Petroleum consumption (PC)

This is the quantity of petroleum consumed in a given period (tonnes) divided by labor force.

Labor force (LF)

This is the total number of employed people.

3.5 Data and Data sources ^

The data on GDP, population, labor force and private capital and petroleum consumption were collected from the various issues of the annual Kenya Economic surveys and statistical abstracts (1980-2008). Relevant data on petroleum consumption was also obtained from the ministry of Energy.

CHAPTER FOUR

DATA ANALYSIS

4.0 Introduction

This chapter presents the analysis of data using the descriptive and regression statistics and the interpretation of the findings.

4.1 Descriptive Statistics

Descriptive summary statistics of the variables shown in Table 4.1 indicate that all variables are normally distributed as their skewness coefficients range from -2 to +2. On the other hand, tests show that all variables except the Per Capita Gross Domestic Product (GDP) exhibited kurtosis value of less than 3. Therefore, results using skewness imply that all variables are normally distributed. However, the Jarque-Bera Test statistic results indicate that the variables are normally distributed except for Per Capita Gross Domestic Product.

Table 4.1: Summary Statistics

	Per capita Gross Domestic Product(GDP)	**Labor Force (LF)**	**Per capita Private Capital(KPC)**	**Per capita Petroleum consumption(PC)**
Mean	20159.14	444*55^2	0.985790	2087.505
Median	12499.78	450.3301	0.962400	2009.000
Maximum	55255.00	498.8712	1.232900	3133.100
Minimum	8369.180	398.8623	0.734300	1373.000
Std. Dev.	13277.33	33.41765	0.127864	502.1769
.Skewness	1.210602	-0.212566	-0.006456	0.589148
JCurtosis	3.426062	1.692126	2.287911	2.472008
jarque-Bera	7.302872	2.285285	0.612911	2.014479
L^robability	0.025954	0.318975	0.736051	0.365226
Observations	29	29	29	29

4.2 Unit Root Tests

As a first step to testing for causality and co-integration, the study sought to verify whether the series had a stationary trend, and, if non-stationary, to establish orders of integration. The study used both Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests to test for stationarity on all the variables. The test results of the ADF and PP tests are presented in Table 4.2a and 4.2b.

Table 4.2a: Tests for Stationarity: Levels

Variable name	ADF test	PP test	1% Level	5% Level	10% Level	Comment
LN Per capita Gross Domestic Product	3.811 (0.001)	3.811 (0.001)	-2.648	-1.953	-1.622	Non Stationary
LN Labor Force	1.119(0.272)	1.119(0.272)	-2.648	-1.953	-1.622	Non Stationary
LN Per capita Private capital	0.014(0.989)	0.014(0.989)	-2.648	-1.953	-1.622	Non Stationary
LN Per capita Petroleum Consumption	1.757(0.090)	1.757(0.090)	-2.648	-1.953	-1.622	Non Stationary

Source: Own Computation

Table 4.2b: Tests for Stationarity: First Difference

Variable name	ADF test	PP test	1% Level	5% Level	10% Level	Comment
LN Per capita Gross Domestic Product	-3.297 (0.003)	'-4.* 14 (0.002)	-2.648	-1.953	-1.622	Stationary
LN Labor Force	-4.907(0.000)	-4.907(0.000)	-2.648	-1.953	-1.622	Stationary
LN Per private capital	-6.178(0.000)	-6.178(0.000)	-2.648	-1.953	-1.622	Stationary
LN Per capita Petroleum ^21^urnPtion	-3.653(0.001)	-3.653(0.001)	-2.648	-1.953	-1.622	Stationary

Source: *Own Computation*

Results in Table 4.2a and 4.2b clearly indicate that all the series have a unit root but on first differencing the series become stationary. The first step for conducting the other tests is therefore satisfied.

4.3. Co-Integration Tests

After ascertaining the stationarity properties of the series, cointegration tests were conducted. The study carried out Johansen Test to test for cointegration. The test in Table 4.3 compared the log likelihood ratios with the t statistics at 5% critical values.

Table 4.3: Cointegration Test Results

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. ofCE(s)
0.563534	49.47062	47.21	54.46	None *
0.485429	26.25734	29.68	35.65	At most 1
0.226402	7.653552	15.41	20.04	At most 2
0.016500	0.465854	3.76	6.65	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Source: Own Computation

From the results the null hypothesis of no-cointegration is rejected at 5% level of significance whereas the null hypothesis of at most one cointegrating equations cannot be rejected. This implies that in the long run, all the variables (GDP per capita, labour force per Capita, private capital per Capita and petroleum consumption) converge to equilibrium.

r t

4.4 Regression Results

After establishing that the variables are stationary at different levels and that they are cointegrated, regression analysis was conducted to establish the relationship between the variables in the long run. Results were presented in Table 4.4.

i

Table 4.4: Results of the Regression Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-69834.67	21922.42	-3.185536	0.0038
LNLABOUR FORCE	68.47283	53.90166	1.270329	0.2157
LNPER CAPITA PRIVATE CAPITAL	23921.73	9861.195	2.425845	0.0228
LNPER CAPITA PETROLEUM CONSUMPTION	17.23219	3.974293	4.335913	0.0002
R-squared	0.840058	Mean dependent variable		20159.14
Adjusted R-squared	0.820865	S.D. dependent variable		13277.33
S.E. of regression	5619.538	Akaike info criterion		20.23333
Sum squared residual	7.89E+08	Schwarz criterion		20.42192
Log likelihood	-289.3833	F-statistic		43.76900
Durbin-Watson statistic	0.535145	Prob(F-statistic)		0.000000

Source: Own Computation

It follows that;

LNGROSS DOMESTIC PRODUCT = -69834.67 + 68.472 LNLABOUR FORCE + 23921.73 LNPER CAPITA PRIVATE CAPITAL + 17.232 LNPER CAPITA PETROLEUM CONSUMPTION

Study findings reveal that the overall goodness of fit of the model is satisfactory as reflected by R-squared of 0.84. This indicates that 84 percent of the variations in Gross Domestic Product are explained by the variables included in the model (labour force, per capita private capital and petroleum consumption). Results obtained in Table 4.5 attempts to satisfy the objectives of the study which sought to determine the long run relationship between petroleum consumption and economic growth. It is evident that petroleum consumption has a positive and statistically significant coefficient at 5% level of significance (as indicated by a coefficient of 17.232 and p value of 0.0002). These results are in agreement with those of Erol and Yu (1988) who found long run relationship between energy consumption and economic growth for eleven developing countries and five developed countries. Study results were also in line with those of Oh and Lee

(2004) who further found evidence of a long run relationship between electricity consumption and economic growth for all GCC countries.

Results further imply that labour force and private capital also have a positive relationship with GDP. The relationship between private capital and GDP is positive and statistically significant as exhibited by a coefficient of 23921.73 and a p value of 0.0228. However, the relationship between labour force and GDP is insignificant as shown by a p value of 0.2157.

4.5 Error Correction Model

Since the variables are co integrated, then we specified an error-correction model to link the short-run and the long-run relationships. The estimates of the error-correction model are 3resented in Table 4.5.

fable 4.5: ECM Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1537.194	599.7836	2.562914	0.0174
DLNLABOUR FORCE	-97.29525	54.08485	-1.798937	0.0852
DLNPER CAPITA PRIVATE CAPITAL	9899.038	4865.978	2.034337	0.0536
DLNPER CAPITA PETROLEUM CONSUMPTION	3.456958	3.620432	0.954847	0.3496
LAGRES	-0.179695	0.107911	-1.665220	0.1094
^-squared	0.342717	Mean dependent variable		1595.841
Adjusted R-squared	0.228407	S.D. dependent variable		3217.938
5.E. of regression	2826^48	Akaike info criterion		18.89200
Sum squared residual	1.84E+08*	Schwarz criterion		19.12990
.og likelihood	-259.4880	F-statistic		2.998140
)urbin-Watson statistic	1.605714	Prob(F-statistic)		0.039627

Source: Own Computation

Results reveal R-squared of 0.342. This implies that 34.2 % of variations in the GDP are •xplained by the explanatory variables in the model. Consequently, 65.8 % of the variations are ^explained. It is clear that there is a positive and statistically insignificant relationship between jDP and lagged petroleum consumption in the short run (coefficient of 3.456 and p value of }-3496).

The error correction term (Lag Res) measures the speed of adjustment to the long run equilibrium in the dynamic model. The error term is negative (-0.1796) and statistically insignificant at the 5% level of significance .This result implies that there is a gradual adjustment (convergence) to the long run equilibrium. The coefficient of -0.1796 indicates that 1.796 % of the disequilibria in GDP achieved in one period are corrected in the subsequent period.

4.6 Causality Results

After testing for stationarity, establishing the order of integration and establishing that the variables are co-integrated, we proceeded to determine whether there was Granger causality between variables used in the model with a view to determining whether GDP had causality with petroleum consumption as well with other study variables. Results are presented in Table 4.6.

Table 4.6: Granger Causality Test Results

Null Hypothesis:		Observation	F-Statistic	Probability
LNLF does not Granger Cause LNGDP		27	0.49835	0.61423
LNGDP does not Granger Cause LNLF			0.27287	0.76373
LNKPC does not Granger Cause LNGDP		27	0.05466	0.94694
LNGDP does not Granger Cause LNKPC			2.94694	0.07346
LNPC does not Granger Cause LNGDP		27	7.57219	0.00315
LNGDP does not Granger Cause LNPC			1.20862	0.31768
LNKPC does not Granger Cause LNLF		27	0.33198	0.72103
LNLF does not Granger Cause LNKPC			1.18835	0.32354
LNPC does not Granger Cause LNFPC		27	2.49926	0.10517
LNLF does not Granger Cause LNPC			3.77307	0.03901
LNPC does not Granger Cause LNKPC	t	27	6.02953	0.00817
LNKPC does not Granger Cause LNPC			0.75228	0.48303

Source: Own Computation

Granger causality tests indicate that the null hypothesis "LNPC does not granger cause LNGDP" ttay be rejected as reflected by a p value of 0.003. Therefore, LNPC granger causes LNGDP. **However,** there was no evidence of reverse causality between LNPC and LNGDP. These findings are consistent with those of Sica (2007) who investigated the possibility of "energy demand-led growth" and "growth-driven energy demand" hypothesis and found evidence of unidirectional causality running from energy to gross domestic product. Study results were also in line with those of Ighodaro and Ovenseri-Ogbomo (2008) for Nigeria who using co integration and bivariate Granger causality technique found unidirectional causality between energy consumption (electricity demand) and economic growth with causality running from energy consumption to economic growth.

Study findings also revealed a unidirectional causality between labour force and petroleum consumption. The null hypothesis that labor force (LNLF) do not granger cause petroleum consumption (LNPC) was rejected on the evidence of p value of 0.039. However, there was no evidence of reverse causality between labour force and petroleum consumption. On the other hand, the null hypothesis "LNPC does not granger cause LNKPC" may be rejected on the evidence of a p value of 0.008. These results imply that there is a very low probability that the null hypothesis is true. Therefore, petroleum consumption (LNPC) granger causes Private capital (LNPC).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY SUGGESTIONS

5.0. Introduction

This chapter summarizes the objectives, methods used and main findings of the study. It also advances the main conclusions that have been drawn from the results and the attendant policy implications. Finally, it points out some potential limitations of the study and potential areas for further research.

5.1 Summary of the Results

This paper sought to find out the relationship between petroleum consumption and economic growth in Kenya. Specifically, it determined the short and long run relationship between petroleum consumption and economic growth and also examined granger causality between consumption, economic growth and petroleum consumption. It adapted a growth model with real GDP per capita as the dependent variable and labour, private capital and petroleum as the independent variables to be estimated.

First, the study determined the stationary of the variables. It was found that all the variables were non-stationary in levels but stationary at first-difference. Second, the Johansen test was then employed to test for cointegration. Cointegration tests indicated that the null hypothesis of no-cointegration was rejected at 5% level of significance. The estimation results of the long-run relationship revealed that the relationship between petroleum consumption and GDP, and private capital and GDP was positive and statistically significant.

Estimation of Error-correction model showed that in short run there was a positive and statistically insignificant relationship between GDP and lagged petroleum consumption. The results also indicated a negative error-correction term of negative 0.1796. A deviation from long-run real GDP in a given year is corrected by about 17.9 % in the next year as suggested by an estimated coefficient of -0.1796. Finally, Granger causality tests imply a unidirectional Granger causality running from petroleum consumption to GDP.

5.2. Conclusion and Policy Implications

Study results indicate that there is short and long-run relationship between petroleum consumption and growth in GDP. The results also indicate a unidirectional relationship running from petroleum consumption to GDP.

Given the long-term positive effects on the economy, the results suggest that an energy growth policy in the petroleum consumption should be adopted in such a way that it stimulates growth in the economy. Such growth would contribute to realization of vision 2030. Therefore, energy policy regarding petroleum consumption may be implemented in such a way that it further boosts economic growth as well as create investment opportunities in Kenya. On the other hand, the uni-directional causality between petroleum consumption and GDP implies that increase in petroleum consumption stimulate economic growth. Therefore, petroleum consumption may be encouraged as it is beneficial to the economy of the country.

To encourage petroleum consumption, both supply side and demand side dynamics should be addressed. For instance, the domestic price of petroleum should be reduced to a level that stimulates both household and industry demand. Fiscal policies such as tax reduction will go along way into reducing the current high prices of petroleum. For instance, Analysts say that Sh55 of the Shi 10 charged per litre of petrol goes to the government as tax. Therefore, a drop in tax by sh 15 would lead to a proportional drop in petrol prices by sh 10. The Keynesian consumption function stipulates that as income increases, consumption of a normal good also increases. It will therefore be in the interest of the current government to address problems such as a runaway inflation, a declining exchange rate so as to enhance the disposable income and the purchasing power of petroleum consumers. This way households and firms will have more money to spend on petroleum as well as other goods.

Structural problems such as the lack of proper storage facility that can stabilize prices during petroleum stocks are indeed necessary. The upgrade of the Kenya pipeline is overdue as it was conducted during the pre colonial era making it unable to handle the required capacity, increasing its vulnerability to fuel siphoning. The old pipeline also doesn't have inbuilt and automated pressure gauges that can warn management of fuel leakages. Measures aimed at improving the service delivery of the Kenya Pipeline Co would also ago along way into enhancing the pricing of petroleum and its subsequent consumption.

5.3. Study Limitations

First, the paucity of data restricted the researcher to have more observations for the analysis when more would have given better and more robust results for time series analysis. Second, the study adopted Cobb-Douglas production function to model the relationship between petroleum consumption and GDP which is ujaally a restrictive functional form.

Thirdly, the study results are naive since they did not attempt to distinguish between the various sources of GDP. For instance, does the relationship hold for the disaggregated form of GDP namely Agricultural GDP, Industry GDP and Service GDP? Which of these sectors bears the highest elasticity to petroleum consumption?

5.4. Areas for Further Research

The findings that there exists a positive relationship between GDP and petroleum consumption does not necessarily imply that increased petroleum consumption would result to an increase in GDP and vice versa. This is because there are other factors that affect petroleum consumption including prices and the exchange rates given that Kenya relies wholly on imports for its petroleum stock.

The study assumed a linear relationship and thus there is need to do a study on the non linear relationship of GDP and petroleum consumption. Other potential areas that might require further investigations include; the impact of energy prices on economic growth, the relationship between gas consumption and economic growth, impact of biomass on economic growth and the impact of energy consumption on total factor productivity.

Furthermore, a relationship between petroleum consumption and the disaggregated form of GDP should be tested so as to test the distributional effects of any policy geared towards petroleum consumption. This way, the Government will know which sector yields the highest impact due to petroleum consumption.

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