

**THE CAUSALITY BETWEEN FINANCIAL DEVELOPMENT AND ENERGY
CONSUMPTION IN KENYA**

JUDY WAIRIMU MBUGUA

X50/69305/2013

**A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN
ECONOMICS OF THE UNIVERSITY OF NAIROBI.
OCTOBER, 2015**

DECLARATION

I declare that this paper is my original work and has not been submitted for the award of a degree in any other university or institution.

JUDY W. MBUGUA

SIGNATURE: DATE.....

This paper is submitted for the award of the degree of Master of Arts in Economics with my approval as a university supervisor.

PROF. PETER K. KIMUYU

SIGNATURE: DATE.....

ACKNOWLEDGEMENTS

My foremost gratitude goes to almighty God for enabling and guiding me through my academic life. I am also grateful to my project supervisor, Professor Peter Kimuyu whose advice, support, time and tireless efforts cannot go unnoticed. His positive criticism, suggestions and prompt comments gave me the impetus to refine and produce quality work.

I appreciate the efforts of my mother, Susan, for her sacrifices, support and constant reassurances; the efforts and support of my dad Oliver, my grandmother Mary, and of my siblings Hannah and Victor; thank you for your support and encouragement. I will not forget the encouragement and input I received from Socrates Majune, Sam Simon Njau, Mr. Njoroge – PhD, and from my classmates, M.A Economics 2013/2014 (both Module I&II).

The views expressed in this paper are my own and do not represent the views of any of the named person(s) and/or Institution(s). I solely bear the responsibility for any errors and/or omissions.

DEDICATION

To my family: my dear parents Susan Njoki and Oliver Mbugua, my siblings Hannah and Victor, and to my grandmother, Mary Karanja; and in memory of my late grandfather, George Karanja Chumbi.

LIST OF TABLES

Table 1: Expected Results	27
Table 2: Descriptive Statistics	29
Table 3: ADF Test Results.....	33
Table 4: Cointegration Results.....	34
Table 5: Regression Results.....	35
Table 6: Granger Causality Results	37
Table 7: Ramsey RESET Test	38
Table 8: Shapiro-Wilk Test for Normality.....	39
Table 9: Breush-Godfrey Serial Correlation LM Test.....	39
Table 10: Breush-Pagan-Godfrey Test for Heteroskedasticity	40
Table 11: Test Results for Multicollinearity-First Equation.....	40
Table 12: Test Results for Multicollinearity- Second Equation	41

LIST OF FIGURES

Figure 1: Trend in Financial Development.....	31
Figure 2: Trend in Energy Consumption	32

TABLE OF CONTENTS

DECLARATION	ii
ACKNOWLEDGEMENTS	iii
DEDICATION	iv
LIST OF TABLES	v
LIST OF FIGURES	vi
TABLE OF CONTENTS.....	vii
ABSTRACT.....	2
CHAPTER ONE	3
1.1. BACKGROUND.....	3
1.1.1. Fuel Production Cycle.....	3
1.1.2. Financing in the Upstream Stage	4
1.1.3. Financing in the Midstream and the Downstream Stages.....	4
1.1.4. Financial Development and Energy Consumption in Kenya.....	4
1.2. STATEMENT OF THE PROBLEM	5
1.3. RESEARCH QUESTIONS.....	6
1.4. OBJECTIVES OF THE STUDY	6
1.5. SIGNIFICANCE OF THE STUDY	7
1.6. ORGANIZATION OF THE STUDY	8
CHAPTER TWO	9

2.	LITERATURE REVIEW	9
2.1.	THEORETICAL LITERATURE.....	9
2.1.1.	Energy Demand and Financial Development	10
2.2.	EMPIRICAL LITERATURE.....	11
2.3.	OVERVIEW OF LITERATURE.....	16
CHAPTER THREE		17
3.	RESEARCH METHODOLOGY	17
3.1	THEORETICAL FRAMEWORK	17
3.1.1	Energy Demand for Households.....	17
3.1.2	Energy Demand for the Firm	18
3.1.3	Financial Development.....	19
3.2	MODEL SPECIFICATION	20
3.3	DATA, ESTIMATION, METHODS AND TESTING PROCEDURES.....	22
3.4	THE GRANGER CAUSALITY TEST	22
3.5	VALIDITY TESTS	25
3.5.1	Stationarity Test	25
3.5.2	Cointegration Test.....	25
3.6	Diagnostic Tests	26
3.7	Expected Results.....	27
3.8	Data.....	28

CHAPTER FOUR.....	29
4 EMPIRICAL ESTIMATION RESULTS.....	29
4.1 DESCRIPTIVE STATISTICS	29
4.1.1 Trend Analysis.....	30
4.2 STATIONARITY TEST	32
4.3 COINTEGRATION RESULTS	34
4.6 POST-ESTIMATION DIAGNOSTICS.....	38
4.6.1 Ramsey RESET Test	38
4.6.2 Shapiro-Wilk Test for Normality	38
4.6.3 Breusch-Godfrey Serial Correlation LM Test	39
4.6.4 Breusch-Pagan-Godfrey Test for Heteroskedasticity	40
4.6.5 Test for Multicollinearity.....	40
CHAPTER FIVE	42
5 SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS	42
5.1 INTRODUCTION.....	42
5.2 SUMMARY OF THE STUDY	42
5.3 CONCLUSION	43
5.4 POLICY IMPLICATIONS AND RECOMMENDATIONS	44
5.5 LIMITATIONS OF THE STUDY	45
5.6 AREAS FOR FURTHER STUDY	45

REFERENCES 46

ABSTRACT

Despite the high demand for energy in Kenya, the Kenyan financial sector has very little to gain from it. Moreover, the financial sector has rarely participated in the energy industry in Kenya. Therefore, the study sought to examine the causal relationship between financial development and energy consumption in Kenya.

The study employs the Engle-Granger Cointegration test, Augmented Dickey Fuller unit root test, and the Granger causality test to investigate the nature of relationship between energy consumption and financial development in Kenya for the 1970-2014 period. The results indicate that energy consumption Granger-causes financial development and not vice-versa (financial development does not Granger-cause energy consumption). Based on this, the study recommends policies that focus on improving and encouraging energy consumption by households and firms as energy consumption has been seen to drive financial development.

CHAPTER ONE

1.1. BACKGROUND

The 1970s oil crisis and its effects revealed the importance of fuel as a factor of production, just like labour and capital; this fact that has been conspicuously overlooked by literature in production and growth theories.

Since the 1970s oil crisis, there has been a persistent increase in fuel consumption globally. In particular, Africa's total fuel consumption risen by 600 percent since 1973 (International Energy Agency, 2014). This could be attributed to the fast rate at which the continent's economy has been becoming industrialized and rapid population growth which has resulted from better health care. The rise is expected to continue. A recent study done by the International Energy Agency (2011) projected that the world petroleum consumption will increase by 38 percent while the world energy consumption will increase by 56 percent by 2040.

1.1.1. Fuel Production Cycle

The fuel production cycle can be viewed in three stages; the upstream, midstream and the downstream. The exploration, extraction, and development of crude oil is done in the upstream stage. It is a capital-intensive stage in oil production. Storing, processing, transporting and marketing of crude oil and other natural gas substances take place in the midstream stage. The downstream operations involve refining crude oil and distribution of the by-products down to the final consumers. The midstream and the downstream operations often overlap. The two stages, therefore, are usually combined (integrated) for most oil companies.

1.1.2. Financing in the Upstream Stage

The upstream stage is capital-intensive and very risky because there is no guarantee that oil will be successfully located. In addition to this, there are many legal impediments that need to be considered before getting into the oil drilling preparation process. They include assessments of the potential environmental impact, purchase of necessary permits and leases and right-of-way accesses.

The global total upstream spending in 2013 increased past the £ 1 Trillion mark for the first time (International Energy Agency, 2014). Tullow, for instance, spent over \$71million in 2013 in Kenya for its exploration exercise that led to the discovery of wells with over 600 million barrels of oil equivalent (mmboe). The wells discovered were Ngamia-1, Twiga South, Etuko, Ekales, Agete, Ewoi, Amosing and Ekunyuk (Tullow Oil, 2013).

1.1.3. Financing in the Midstream and the Downstream Stages

Since independence, Kenya has been an oil-importing country. This implies that Kenya has been actively involved in the midstream and downstream stages; only that it recently halted its oil refinery processes in 2013.

PWC (2013) did a survey whose results indicated that although private equity only accounted for 28 percent of total oil and gas financing, it was the fastest growing source of capital for oil and gas companies in Africa. The results also indicated that international organizations account for 72 percent of the sources of funds for oil and gas companies in Africa.

1.1.4. Financial Development and Energy Consumption in Kenya

Financial development is an extensive phenomenon. This is because it entails establishment and sustainability of institutions, markets, policies and factors that support growth and investments.

Therefore, financial development provides a way in which energy demand can be increased, consequently affecting economic growth (Sadorsky, 2010).

Kenya is considered to have one of the most developed financial systems in sub-Saharan Africa (Odhiambo, 2008) . Currently there are about 43 commercial banks, 6 representative offices of foreign banks, 4 non-bank financial institutions (NBFI's), 2 mortgage finance companies , 89 foreign exchange bureaus, 2 building societies, a large Post Office Savings Bank and a well-established Nairobi Securities Exchange - the fourth largest securities exchange in Africa, among others (CBK, 2014). In addition to this, Kenya has the best mobile banking system in the world, which further emphasizes on the development of Kenya's financial system.

Whilst the financial system in Kenya has continuously grown since independence energy consumption has been erratic over the years in Kenya. In 1971, 453.25 kg of energy per capita was consumed. It decreased to 452.30 kg of energy per capita in 1980, increased to 455.29 kg of energy per capita in 1990, declined to 449.26 kg of energy per capita in 2000 and increased to 482.02 kg of energy per capita in 2010 (International Energy Agency, 2014).

As a consequence of increasing bank deposits, there has been a higher demand for products and services. It has lead to the general increase in energy consumption (from 453.25 kg of oil per capita in 1971 to 482.02 kg of oil per capita in 2010).

1.2. STATEMENT OF THE PROBLEM

The energy industry requires massive financing, in all the energy consumption stages. However, Kenyan banking industry has a very low capacity to finance the energy industry. According to Gachiri (2013) and Andae (2014), data from the Central Bank of Kenya showed that the entire Kenyan banking industry could not afford to finance the fuel industry. Whether energy

consumption causes financial development or vice versa would be some of the questions raised based on this.

Although few studies have tested for the causality between energy consumption and financial development, there have been inconsistent and diverse findings. While some studies found bi-directional causality (Shahbaz & Lean, 2012), others found that energy consumption Granger-causes financial development (Chtioui, 2012; Mulali & Sab, 2012(a)). Yet other studies found that financial development Granger-causes energy consumption (Kakar, Khilji, & Khan, 2011; Dan & Lijun, 2009).

Since the nature of relationship between energy consumption and financial development is not clear from literature, this study seeks to examine the nature of this relationship and the direction of causality in the Kenyan case.

1.3. RESEARCH QUESTIONS

- a) Is financial development related to energy consumption in Kenya?
- b) What is the direction of relationship between financial development and energy consumption in Kenya?

1.4. OBJECTIVES OF THE STUDY

The general objective of this study is to investigate the causal relationship between financial development and energy consumption in Kenya.

The specific objectives of this study are:

- a) To establish the relationship between financial development and energy consumption in Kenya.
- b) To examine the direction of causality between financial development and energy consumption in Kenya
- c) To draw up policy recommendations that encourage positive interaction between financial development and energy consumption based on the findings of the study.

1.5. SIGNIFICANCE OF THE STUDY

In addition to shedding light on the divergent views found in literature concerning the nature of the relationship between financial development and energy consumption, this study aims at enlightening monetary policy decision-makers on the importance of favorable interest rates and financial development in the energy sector. Further, it will enable energy policy-makers come up with appropriate decisions that support economic growth driven by financial development.

The results of this study can have important policy implications. If a unidirectional causality exists from financial development to energy consumption, then policies to promote financial development would increase energy consumption. It also implies that energy, conservation, and sustainability policies may be implemented without adversely affecting financial development. On the other hand, if causality runs from energy consumption to financial development, then the financial development is determined by energy consumption. It implies that a decline in energy consumption may negatively affect financial development and consequently lead to poor economic performance. Bi-causality between financial development and energy consumption would imply that financial development cannot be achieved without a commensurate amount of

energy consumption.

1.6. ORGANIZATION OF THE STUDY

This proposal is organized into three chapters; chapter one provides the introduction and comprises of the background, statement of the problem, objectives, and significance of the study, the scope of the study and the organization of the study. Chapter two contains the theoretical and empirical literature review and an overview of the literature. Chapter three presents the theoretical and empirical frameworks, model specification and describes the data sources.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter reviews the existing theoretical and empirical literature in this area of study. Also, it attempts to relate this study to available literature. It starts with the theoretical literature then empirical literature followed by an overview of available literature.

2.1. THEORETICAL LITERATURE

According to Sadorsky (2010) and Sadorsky (2011), financial development is part of financial liberalization, which is important to activate the equity market, encourage greater level of transparency in transactions, allow easy access to financial capital for investment across countries and lower the financial risk of borrowing costs between lenders borrowers.

Based on these reasons, Sadorsky (2010), Sadorsky (2011) and Tang & Tan (2012) came up with two main hypotheses on how financial development would affect the demand for energy. The first hypothesis proposed that financial development enhances economic efficiency and growth, which in turn leads to increased demand for energy. One of the most common ways that financial development can influence energy consumption is by making it easier for consumers and producers to borrow money to purchase more energy-consuming assets like home electrical appliances, machinery, automobiles and houses (Sadorsky, 2011). In addition to this, financial development allows businesses to easily access capital. Such capital can be used to enlarge business through either construction of new manufacturing plants or through expansion of existing operations. Consequently the energy for demand would increase (Sadorsky, 2010). In this way, financial development increases (Granger-causes) energy consumption.

Second, financial development can improve energy efficiency by lending money to support the development of energy savings industries and infrastructure (Tang & Tan, 2012; Islam, Shahbaz, & Alam, 2011; Kakar, Khilji, & Khan, 2011). Based on this hypothesis, financial development reduces energy consumption.

2.1.1. Energy Demand and Financial Development

Micro-economic theory defines demand as the quantity (or amount) of a good or service people are willing and able to buy at different prices. The determinants of demand are price of the good, prices of related goods, price of other goods, disposable income, preferences and tastes, among others.

Since energy is a normal good, its demand is not any different from that of normal goods. Consequently, there are many explanations for an increase, or decrease of energy demand (Bhattacharyya & Timilsina, 2009). While individuals aim at maximizing utility by consuming energy and other goods with the constraint of disposable income, firms focus on minimizing their total cost. They do this after using energy as an input of production (Bhattacharyya & Timilsina, 2009).

Bagehot (1873) was the first to investigate on the mechanism in which growth is influenced by financial development. He explained that the size and organization of capital markets boosted productive investments through efficient resource allocation. The second was Schumpeter (1911), who postulated that economic development can be enhanced if there is a financial sector that mobilizes productive investments and savings. The importance of the financial sector was also highlighted by Hicks (1969). He explained that for successful industrial revolutions, there has to be stable financial markets.

McKinnon (1973) and Shaw (1973) proposed the financial repression and financial development framework, which has been the main platform for the financial sector policies for many countries. According to the framework, aggregate investments are reduced by financial repression. This happens because a low interest rate daunts people from holding deposits in financial institutions. Consequently, potential productive investments lose out (Huang, 2010).

According to theory, income and interest rate are considered to be determinants of financial development (Levine, 2005). In addition, the growth of an economy leads to a decrease in the financial intermediation costs. This is because of increased competition which prompts bigger productive investments from a wider pool of funds available.

Jaffe and Levonian (2001) conducted a study in 23 economies that focused on the banking sector development. Their study indicated that the banking system and structure, including the interest rate, the ratio of bank deposits to credit, bank assets and employees are positively affected by GDP per capita.

2.2. EMPIRICAL LITERATURE

Although there is a high importance of energy consumption- financial development causality analysis, the relationship between financial development and energy consumption is a pristine area with very few recent studies that have been carried out in both developed and developing countries. In addition to this, there is no consensus on the results obtained from the few recent studies.

Some studies found bi-directional causality between financial development and energy consumption. For instance, Shahbaz and Lean (2012) found out that there is a long-run relationship among financial development, industrialization, energy consumption, urbanization

and economic growth. Their study, which aimed at assessing the relationship among various variables in Tunisia, employed the ARDL approach to integration.

However, Shahbaz and Lean (2012) failed to come up with exploitable conclusions by focusing on Tunisia, an oil-exporting country. Their conclusion is not applicable to oil-importing countries such as Kenya. This study aims at coming up with conclusions and policy recommendations that are relevant to Kenya and other oil-importing countries. Contrary to their study, this study used the Engle-Granger approach to cointegration. Further, in order to get more comprehensive results, this study's model incorporated other variables such as interest rate and the ratio bank deposits to credit while omitting industrialization and urbanization.

In their study, Shahbaz and Lean (2012) used the Granger Causality approach to investigate long-run bidirectional causality between financial development and energy consumption. This study used the same approach in order to establish the nature of causality between financial development and energy consumption in Kenya.

Another study, which focused on establishing whether there existed a long-term relationship amongst energy consumption, economic growth and financial development was conducted by Islam, Shahbaz and Alam (2011). They employed the use of Auto Regressive Distributed Lag (ARDL) approach to cointegration. Their findings indicated that economic growth and financial development Granger-cause energy consumption both in the long and the short-run.

By applying the error-correction model, Chtioui (2012) attempted to establish the relationship between economic growth, energy consumption, and financial development in Tunisia. According to his findings, energy consumption Granger-causes financial development in the short-run while economic growth and energy consumption Granger-cause each other.

However, just like Shahbaz and Alam (2011), Chtioui (2012) conclusions are irrelevant to the policies of oil-importing African countries. This study, therefore, fills this gap by coming up with policy recommendations that are applicable to oil-importing countries in Sub-Saharan Africa.

By employing the Johansen Cointegration test, Augmented Dickey Fuller unit root test, and the Granger causality test, Kakar, Khilji and Kakar (2011) attempted to investigate the relationship between energy consumption, economic growth, and financial development in Pakistan for the period 1980-2009. They found out that financial development Granger-causes energy consumption and from this, they drew the implication that financial development that can be used as an effective measure to overcome energy problems by achieving efficiency in energy use.

A study with interesting and contrary findings was done by Dan and Lijun (2009). They examined the impact of financial development on primary energy consumption in China. They used the Granger Causality approach to determine the direction of relationship between financial development and energy use. Their empirical results showed that the direction of relationship is unidirectional running from energy consumption to financial development. However, the reverse order of relationship (from financial development to energy demand) was not statistically significant.

An examination of the nature of the relationship between energy consumption, income, financial development, and carbon dioxide emissions by incorporating investment and employment as potential determinants of domestic production in Sub-Saharan African countries was done by Mulali and Sab (2012). They used the Granger Causality test to establish that energy consumption plays a vital role on financial and economic development. Their results indicated that

energy consumption Granger-causes financial development. Based on their results, Mulali and Sab (2012) concluded that a rise in economic growth and energy consumption adds to demand of financial services which subsequently leads to an increase in the improvements in environmental quality by controlling CO₂ emissions through the implementation of well-organized and transparent financial policies. A subsequent study conducted by Mulali and Sab (2012b) consisting of 19 developed and developing countries yielded the same results as their previous study.

One of the first consumption-financial development studies was done by Love and Zicchino (2006). They conducted a study with an aim of establishing the linkage between financial development and key monetary variables. They used the traditional Granger Causality approach to determine the direction of relationship between financial development and energy use. Love and Zicchino (2006) found out that financial development does not instantly influence energy consumption. The study, further, found out that financial development passes through the real sector growth to increase per capita income. They concluded that financial development is positively related to energy demand; implying that an increment in per capita income may increase the demand for more energy consuming durable goods such motor vehicles.

Karanfil (2009) introduced financial elements in the energy-growth framework. This development urged Sadorsky (2010) and Sadorsky (2011) to test the framework by Karanfil (2009). Sadorsky (2010) and Sadorsky (2011) found that financial development is important to the demand for energy through improvement of the economic efficiency of a country's financial system.

Sadorsky(2010), By employing different measures of financial development, investigated the impact of financial development on energy demand using a panel of 22_developing economies

for the period 1990-2006 by employing the GMM estimation techniques. His results showed a positive and statistically significant relationship between financial development and energy consumption when financial development is measured using stock market variables like stock market value traded to GDP, stock market capitalization to GDP, and stock market turnover to GDP.

Later, Sadorsky (2011) investigated the impact of financial development on energy consumption for a panel of 9 developed economies in Europe. His results showed a positive relationship between financial development and energy consumption when financial development is measured using banking variables like deposit money bank assets to GDP, financial system deposits to GDP, or liquid liabilities to GDP. Just like in Sadorsky (2010), he used several different measures of financial development and the GMM estimation technique.

Conversely, Sadorsky (2010) failed to establish the causality direction among the variables and only looked at correlation issues. In addition to this, the financial variables that he used did not include variables from the bank sector which is part of the financial sector. In order to come up with more reliable findings, this study aims at investigating on the direction of causality between financial development and energy consumption in Kenya. Further, this study uses the ratio of domestic credit to private sector to GDP as a proxy for financial development. This is an important financial development measure because it accounts for the actual funds collected from bank depositors and disseminated to investors by banks (Levine, 2003).

2.3. OVERVIEW OF LITERATURE

Generally, for the few studies that focus on the relationship between energy consumption and financial development, they show no consistency in their results on the nature of relationship. Some studies found uni-directional causality relationship either moving from financial development to energy consumption (Dan & Lijun, 2009; Kakar, Khilji, & Khan, 2011) or from energy consumption to financial development (Chtioui, 2012; Mulali & Sab, 2012(a)), while others found bi-directional causality (Shahbaz & Lean, 2012) or no causality, hence empirical evidence of this relationship is unclear.

Since the nature of relationship between energy consumption and financial development is not clear from literature, this study seeks to examine the nature of this relationship and the direction of causality in Kenya.

CHAPTER THREE

3. RESEARCH METHODOLOGY

This chapter discusses some of the models developed to link the relationships between energy consumption and aggregate output.

3.1 THEORETICAL FRAMEWORK

According to micro-economic theory, the demand of a normal good is a function of its own price, income, among other factors.

If this theory is applied to energy demand, then;

$$Q_e = f(P_e, Y, \varepsilon) \dots\dots\dots\text{Equation 1}$$

Where:

Q_e is energy demanded

P_e is the price of energy

Y is the income level

ε - represents other factors that affect energy demand.

While individuals aim at maximizing utility by consuming energy and other goods with the constraint of disposable income, firms focus on minimizing their total cost. They do this after using energy as an input of production (Bhattacharyya & Timilsina, 2009). Consequently, the energy demand analysis will treat these two categories separately.

3.1.1 Energy Demand for Households

The individual consumer aims at maximizing utility subject to his budget constraint.

$$\text{Max. } U(E, X_1, X_2, \dots, X_n) \dots\dots\dots\text{Equation 2}$$

Subject to: $Y = P_E E + P_1 X_1 + P_2 X_2 + \dots + P_n X_n$ Equation 3

The Lagrangian function becomes:

$L = U(E, X_1, X_2, \dots, X_n) - \lambda(Y - (P_E E + P_1 X_1 + P_2 X_2 + \dots + P_n X_n))$ Equation 4

Solutions include demand for energy: $E = f(P_E, Y, P_1, P_2, \dots, P_n)$ Equation 5

Where:

E is the individual consumer's energy consumption

X_1 , is good 1

X_2, \dots, X_n represent goods 2 to good n

Y is the consumer's disposable income

P_E is the unit price of energy

P_1 is the price of good 1

P_2, \dots, P_n represents the prices of goods 2 to n

$U(E, X_1, X_2, \dots, X_n)$ represents a consumers utility which is derived from energy

3.1.2 Energy Demand for the Firm

According to theory and literature Bhattacharyya and Timilsina (2009), the firm's objective is to minimize costs subject to quantity produced.

Min $TC = C_E E + C_1 X_1 + C_2 X_2 + \dots + C_n X_n$ Equation 6

Subject to: $Q = f(E, X_1, X_2, \dots, X_n)$ Equation 7

The Lagrangian function becomes:

$$L = C_E E + C_1 X_1 + C_2 X_2 + \dots + C_n X_n - \lambda(Q - f(E, X_1, X_2, \dots, X_n)) \dots \dots \dots \text{Equation 8}$$

The solution includes:

$$E = f(C_E, C_1, \dots, C_n, Q)$$

X_1 , is input 1

X_2, \dots, X_n represents inputs 2 to n

Q is the output

E is the energy input

C_E is the unit cost of energy input

TC is the total cost of production

C_1 is the unit cost of input 1

C_2, \dots, C_n represents the unit costs of inputs 2 to n

3.1.3 Financial Development

From the theory of financial development, variables such as GDP, interest rate, level of income, ratio of bank deposit to credit, among others cause financial development (Greenwood & Jovanovic, 1990; Levine, 2005):

$$FD = f(GDP, i, y, BDVC) \dots \dots \dots \text{Equation 9}$$

Where:

FD is financial development

i is the interest rate

y is the level of income

BDVC is the ratio of bank deposits to credit

3.2 MODEL SPECIFICATION

Existing literature suggests that financial development influences energy consumption through wealth, consumer and business effect (Sadorsky, 2010). Existing literature further postulates that other factors that influence energy consumption include interest rates and the ratio of bank deposits to credit (Tang, 2009 ; Tang & Tan, 2012). If we modified the model from Sadorsky (2010), the functional form of the energy demand function can be constructed as:

$$EC_t = f(P_t, Y_t, FD_t, EC_{t-1}, \dots, EC_{t-n}, BDVC_t, i_t) \dots \dots \dots \text{Equation 10}$$

Further, a non-linear relationship exists between energy consumption and its determinants (Tang & Tan, 2012). This implies that;

$$EC_t = \beta_0 + P_t^{\beta_1} Y_t^{\beta_2} FD_t^{\beta_3} EC_{t-1}^{\beta_4} \dots EC_{t-n}^{\beta_{5-n}} BDVC_t^{\beta_5} i_t^{\beta_6} \dots \dots \dots \text{Equation 11}$$

The theory of financial development is a describes financial development as a function of variables such as GDP, interest rate, level of income, the ratio of bank deposits to credit, among others (Greenwood & Jovanovic, 1990; Jaffe & Levonian, 2001; Levine, 2005). In addition to describing energy consumption as a determinant of financial development, Sardosky (2010) explained that there exists a non-linear relationship between financial development and it's determining factors. The financial development function, therefore, can be described as:

$$FD = \beta_0 + P_t^{\beta_1} Y_t^{\beta_2} EC_t^{\beta_3} FD_{t-1}^{\beta_4} \dots FD_{t-n}^{\beta_{5-n}} BDVC_t^{\beta_5} i_t^{\beta_6} \dots \dots \dots \text{Equation 12}$$

- Where n is the number of lags which will be determined through the Akaike's Information Criterion (AIC).

Gujarati (2004) postulates that using the logarithm of one or more variables instead of the unlogged form makes a non-linear equation effective. Further, Gujarati (2004) asserts that logarithmic transformations are a convenient way of transforming a highly skewed variable into one that is more approximately normal. Transforming the empirical equation of the model into logarithmic form leads to these expressions:

$$\ln EC_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln FD_t + \beta_4 \ln EC_{t-1} + \dots + \beta_{5-n} \ln EC_{t-n} + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t \dots \dots \dots \text{Equation 13}$$

$$\ln FD_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln EC_t + \beta_4 \ln FD_{t-1} + \dots + \beta_{5-n} \ln FD_{t-n} + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t \dots \dots \dots \text{Equation 14}$$

Where:

- $\ln EC_t$ is the natural log of energy consumption per capita.
- $\ln P_t$ is the natural log of the energy price
- $\ln Y_t$ is the natural log of income (proxied for economic growth)
- $\ln FD_t$ is the natural log for financial development (proxied by the credit - GDP ratio).
- $\ln EC_{t-1} \dots \ln EC_{t-n}$ are the natural logs of lagged energy consumption
- $\ln BDVC_t$ is the natural log for the ratio of bank deposits to credit
- $\ln FD_{t-1} \dots \ln FD_{t-n}$ are the natural logs of lagged financial development
- $\ln i_t$ is the natural log of interest rate
- μ_t is the residual term with assumption for normal distribution.
- n is the number of lags.

- β_1 is price elasticity
- β_2 is income elasticity
- β_3 is the financial development elasticity
- $\beta_4 \dots \beta_{5-n}$ are the lagged energy consumption elasticities
- β_5 is the elasticity of the ratio of bank deposit to credit
- β_6 is the interest rate elasticity

3.3 DATA, ESTIMATION, METHODS AND TESTING PROCEDURES

In order to investigate the relationship between financial development and energy in Kenya, a two-step procedure was adopted. First, validity tests were done; time series properties of the data were investigated by use of unit root test and long- run relationship investigated by use of cointegration analysis. Second, the Granger Causality test was conducted.

3.4 THE GRANGER CAUSALITY TEST

The Granger causality analyses two variables together, testing their interaction. The test assumes that the information relevant to the prediction of the respective variables, y_t and x_t , is contained solely in the time series data on these variables. The Granger causality test analyses the extent to which the change of past values of one variable accounts for later variation of other variables (Granger, 1986).

If Granger causality exists between y_t and x_t , then variable y_t can be predicted with precision by past values of x_t .

As an example, the Granger causality test involves estimating the following pair of regressions:

$$y_t = \sum_{i=1}^n \alpha_i x_{t-i} + \sum_{j=1}^n \beta_j y_{t-j} + \mu_{1t} \dots\dots\dots \text{Equation 12}$$

$$x_t = \sum_{i=1}^n \lambda_i x_{t-1} + \sum_{j=1}^n \delta_j y_{t-j} + \mu_{2t} \dots\dots\dots \text{Equation 13}$$

- Assuming that μ_{1t} and μ_{2t} are uncorrelated.

Equation 15 postulates that the values of y at time t is related to past values of x while equation 16 postulates that the values of x is related to past values of y .

Unidirectional Granger causality from variables x_t to variables y_t will be present if the estimated coefficients on the lagged x in equation 15 are statistically different from zero, i. e. , $\sum_{i=1}^n \alpha_i \neq 0$ and the set of estimated coefficients on the lagged y coefficients in equation 16 are not statistically different from zero, i.e., $\sum_{j=1}^n \delta_j = 0$ (Gujarati, 2004).

Unidirectional Granger causality from variables y_t to variables x_t will be present if the estimated coefficients on the lagged x in equation 15 are not statistically different from zero, i. e. , $\sum_{i=1}^n \alpha_i = 0$ and the set of estimated coefficients on the lagged y coefficients in equation 16 are statistically different from zero, i.e., $\sum_{j=1}^n \delta_j \neq 0$ (Gujarati, 2004).

Bi-directional causality would be present when sets of x and y coefficients are statistically and significantly different from zero in both regressions. There will be not causality between x and y when the sets of x and y coefficients are not statistically significant in both the regressions.

Further, if we include lagged values of x and it significantly improves the prediction of y , then we can say that x Granger-causes y . Similarly, if we include lagged values of y and it significantly improves the prediction of x , then we can say that y Granger-causes x .

Application of the Granger Causality Test on Financial Development and Energy Consumption

$$\log FD_t = \beta_0 + \sum_{i=1}^n \beta_i \log FD_{t-i} + \sum_{j=1}^n \alpha_j \log EC_{j-1} + U_t \dots\dots\dots \text{Equation 14}$$

$$\log EC_t = \theta_0 + \sum_{i=1}^m \gamma_i \log FD_{t-i} + \sum_{j=1}^m \delta_j \log EC_{j-1} + V_t \dots\dots\dots \text{Equation 15}$$

Where U_t and V_t are mutually uncorrelated white noise errors and:

- t is the time period
- i and j are the number of lags

$$H_0 : \alpha_i = \delta_i = 0$$

$$H_1 : \alpha_i \neq \delta_i \neq 0 ; \text{ At least for some } i\text{'s.}$$

If α_i 's and δ_i 's are significant, then causality runs in both ways (bi-directional causality).

If α_i 's are statistically significant but δ_i 's are not, then financial development causes energy consumption. On the other hand, if δ_i 's are statistically significant but α_i 's are not, then energy consumption causes financial development.

The Procedure

- a) In order to obtain the restricted residual sum of squares (RSS_R), a restricted regression of financial development (FD) on all lagged FD terms and other variables is done
- b) To find the unrestricted residual sum of squares (RSS_{UR}), an unrestricted regression is done through the inclusion of Energy Consumption (EC) in the regression.
- c) The F-Test is applied with m and $(n-k)$ degrees of freedom in order to test the null hypothesis ($H_0 : \alpha_i = \delta_i = 0$),

$$F = \frac{(RSS_R - RSS_{UR})/m}{\frac{RSS_{UR}}{(n-k)}} \dots\dots\dots \text{Equation 169}$$

Where m = the number of lagged Energy Consumption terms and k is the number of parameters estimated in the unrestricted regression.

- d) Decision Stage: If the computed F exceeds the critical F value at the chosen level of significance, we reject the null hypothesis, in which case the lagged EC terms belong in the regression. This is another way of saying that energy consumption causes financial development.

- e) The steps are repeated to test whether financial development causes energy consumption (Gujarati, 2004).

3.5 VALIDITY TESTS

For Granger causality test to be valid, the variables must not be cointegrated (Granger, 1986). In addition to this, the results of Granger causality are sensitive to the selection of the lag length. In order to ensure the validity of the test and its consequent results, stationarity and cointegration tests are done prior to undertaking the Granger causality test.

3.5.1 Stationarity Test

In order to avoid the problem of a spurious regression, stationarity is established by conducting a unit root test. The spurious regression problem occurs when regressing two un-related series seem to have a statistically significant relationship.

The Augmented Dickey and Fuller (1981) approach is applied in this study by use of the model:

$$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \sum_{i=1}^m \alpha_i \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots \text{Equation 20}$$

Where ε_t is a pure white noise error term,

$$\text{And } \Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}) ; \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$$

3.5.2 Cointegration Test

Cointegration occurs when variables have a long-term or equilibrium relationship between them. Testing for cointegration is done using the Engle-Granger two-step procedure (Granger, 1986; Engle & Granger, 1987).

The procedure tests whether the regression residuals of the following long-run regressions are stationary:

$$\log FD = \beta_0 + \beta_1 \log EC + \beta_2 \log P + \beta_3 \log i + \beta_4 \log Y + \beta_5 \log BDVC + U_1 \dots\dots\dots \text{Equation 21}$$

$$\log EC = \theta_0 + \theta_1 \log FD + \theta_1 \log P + \theta_1 \log Y + \theta_1 \log BDVC + \theta_1 \log i + U_2 \dots\dots\dots \text{Equation 22}$$

Where:

- $\log EC$ is the logarithm of energy consumption per capita.
- $\log P$ is logarithm of the energy price
- $\log Y$ is the logarithm of income (proxied for economic growth)
- $\log FD$ is the logarithm for financial development (proxied by the credit - GDP ratio).
- $\log BDVC$ is the logarithm for the ratio of bank deposits to credit
- $\log i$ is the logarithm of interest rate

Where U_1 and U_2 are error terms assumed to be uncorrelated, with zero mean and constant variance. The equations will be estimated using Ordinary Least Squares method (OLS).

Variables must be integrated of the same order to form a cointegrating relationship.

If the variables will be non- stationary at levels and the linear combination of them is non- stationary, the standard Granger causality test will be used. If the series will be non- stationary at levels and there will be a long- run relationship among the variables, then the VECM approach will be used (Yang, 2000). If the variables will not be cointegrated, then VAR- based Granger Causality test will be used.

3.6 Diagnostic Tests

In order to ascertain the fit of the model, the validity of inferences made from the estimated results and to examine the structure of the residuals, post-estimation tests were conducted. These tests include:

- a) Jarque-Bera (JB) Test for normality – Is based on the OLS residuals where the null hypothesis postulates that the residuals are normally distributed.
- b) Ramsey’s RESET Test – It was used to test for model specification error
- c) Residual normality test
- d) Residual autocorrelation LM test
- e) Residual heteroskedasticity test

3.7 Expected Results

Below is a summary of the expected relationship between energy consumption and the other variables:

Table 1: Expected Results.

	Variable	Expected relationship with energy consumption	Basis and references
1	Price (P)	-	Micro-economic theory postulates that price is negatively related to demand/consumption except for non-normal goods. Energy is a normal good (Bhattacharyya & Timilsina, 2009)
2	Income (Y)	+	According to economic theory, the income is positively related to demand/consumption
3	Bank deposit to Bank Credit (BDVC)	+	Greenwood & Jovanovic (1990); Jaffe & Levonian (2001); Levine (2005)

4	Interest Rate (<i>i</i>)	-	Jaffe & Levonian (2001) and Levine (2005)
5	Lagged Energy Consumption	+	Islam, Shahbaz and Alam (2011)
6	Financial Development	+	Dan and Lijun (2009) and Mulali and Sab (2012)

Source: Author

3.8 Data

The study used annual data covering the period 1970– 2014 taken from the World Bank World Development Indicators (WDI) and World Data Bank. Energy consumption is measured in nominal terms by total energy consumption (kg of oil equivalent). Financial development was proxied by the ratio of domestic credit to private sector as a share of GDP (Levine, 2003). This proxy properly indicates financial deepening through the actual amount of funds collected from savers and distributed by banks to investors for investment projects.

Interest, which is measured in nominal terms is the lending interest rate without any inflation adjustment. The ratio of bank deposit to bank credit is measured as a percentage of bank deposits to bank credit. It incorporates deposits and credit by banks and other financial institutions. Price is proxied by the consumer price index for 2010 = 100 while income is proxied by nominal GDP which is measured in nominal terms in U.S. dollars.

CHAPTER FOUR

4 EMPIRICAL ESTIMATION RESULTS

In this section, the results from the empirical estimation and their economic interpretations are presented. The section begins by presenting the descriptive statistics of all the variables in the estimable model and then goes further to establish the time series properties of the variables. Finally, the model is estimated in light with the Error correction methodology and post estimation tests conducted on the model.

4.1 DESCRIPTIVE STATISTICS

In order to determine the statistical properties of the data, a descriptive analysis was conducted. A summary of the analysis which gives the mean, median, standard deviation, skewness, kurtosis, the Jarque-Bera statistic and the probabilities of all the variables in the model is presented below:

Table 2: Descriptive Statistics

Variable	Mean	Median	Standard Deviation	Skewness	Kurtosis	JB Statistic	Probability
LnFD	3.3264	3.7440	0.2072	0.0086	0.0789	8.5700	0.0138
LnEC	9.2916	0.3189	0.4319	0.8542	0.0099	6.2000	0.0451
LnINCOME	26.340	26.3010	1.8405	0.8042	0.0011	9.0300	0.0109
LnINTEREST	1.8216	1.9192	0.8382	0.0937	0.9307	3.0000	0.2233
LnPRICE	2.5154	2.5844	1.6090	0.7231	0.0001	13.0900	0.0014
LnBDVC	4.3447	4.3550	0.0769	0.0672	0.1577	5.2000	0.0744

Source: Author's analysis using STATA

Standard deviation measures the extent of dispersion of the series from the mean. From the low standard deviation values of the analysis, it is clear that all the natural logarithms of all the variables are not significantly dispersed from their mean values.

In order to test for normality, the Jarque-Bera test was used. The Jarque-Bera checks for normality by measuring the difference of kurtosis and skewness of the series with that from a normal distribution. From the analysis, although the Jarque-Bera statistic rejects the null hypothesis of normal distribution of price, it accepts the null hypothesis of normal distribution for financial development, energy consumption, income, interest, the ratio of bank deposits to credit at 1% and 5% levels of significance.

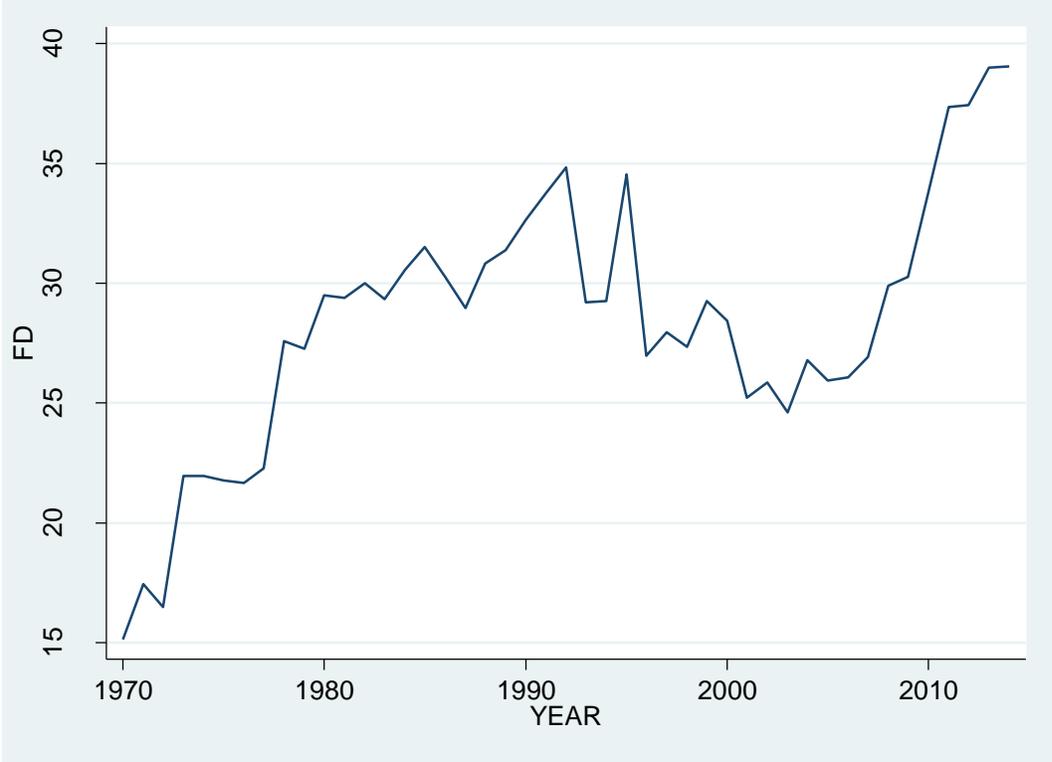
Skewness, a measure of asymmetry of a distribution around its mean, was done. The analysis shows that the statistic for skewness for all the variables are positively skewed, inferring that all variables have long right tails distributions. Further, the skewness statistics for financial development, interest and the ratio of bank deposits to credit indicate that their respective distributions are approximately symmetric while the skewness statistics for energy consumption, income, and price show that the respective distributions are moderately skewed.

Kurtosis is a measure of peakedness or flatness of the series distribution. From our analysis, the kurtosis statistic of all variables is platykurtic. This implies that all the variables' distributions have a wider peak and are flatter than a normal distribution. It also implies that there is a lower probability for extreme values than for a normal distribution.

4.1.1 Trend Analysis

In order to detect the movements in the value of main variables over time and to analyze the causes of such movements, a trend analysis was conducted.

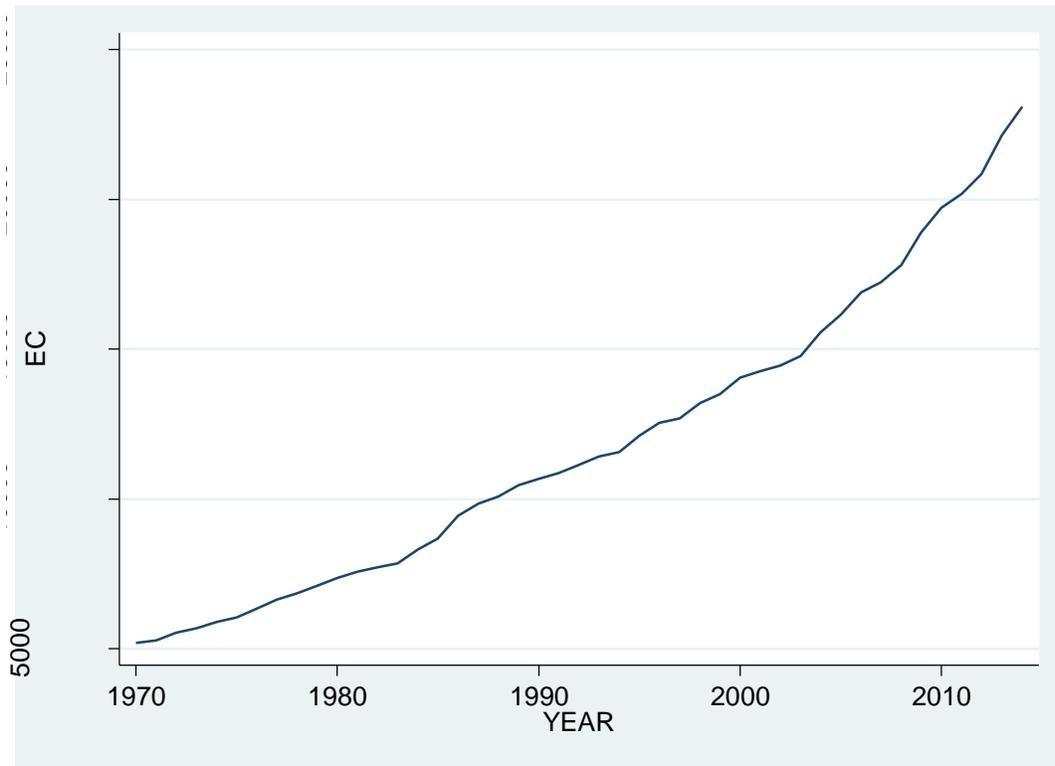
Figure 1: Trend in Financial Development



Source: Researcher's Own graphing from data using STATA

Figure 1 shows that the real value of financial development generally increased, although inconsistently between 1970 and the mid 1980's before it's volatility that extended up until the mid-2000. Since then it has continued to steadily rise.

Figure 2: Trend in Energy Consumption



Source: Researcher's Own graphing from data using STATA

Figure 2 shows that the real value of energy consumption has steadily and consistently risen since 1970 to 2014.

4.2 STATIONARITY TEST

In order to ascertain whether the variables are stationary or non-stationary, and to consequently avoid a spurious regression, a unit root test was conducted. A spurious regression occurs when two unrelated series seem to have a statistically significant relationship when regressed. The ideal situation is when variables have a constant mean, variance and the covariance between the values of two time periods is zero.

Although there are many tests that can be used to test for unit roots, the Augmented Dickey-Fuller (ADF) test was conducted; with trend and without trend. The Akaike Information Criterion (AIC) was employed as the basis of lag length selection of the ADF test where the following hypothesis was tested:

The hypothesis for ADF Unit Root Test:

H0: Time-series is not stationary or there is a unit root.

H1: Time-series is stationary or there is no unit root.

Table 3: ADF Test Results

VARIABLE	Levels		Order of Differencing	Differences		Lags
	Trend	No Trend		Trend	No Trend	
lnFD	-2.738***	-1.310	1	-8.529*	-3.583**	1
lnEC	0.217	-1.826	1	-5.648*	-3.725*	1
lnINCOME	-1.049	-1.896	1	-5.165*	-3.500**	5
lnINTEREST	-3.915**	-2.914	1	-8.213*	-7.693*	1
lnPRICE	-0.884	-1.989	1	-3.973*	-3.137***	1
lnBDVC	-3.997**	-2.713	1	-7.800*	-4.135*	1

Source: Researcher's own tests using STATA

Asterik (*) = Significance at 1%; (**) = Significance at 5%; (***) = Significance at 10%

According to the results, the all the time series variables have unit roots and that the null hypothesis cannot be rejected for the levels. This is because their ADF values are greater than the critical values at the 1%, 5% and 10% levels of significance. This implies that financial

development, energy consumption, income, interest, price and the ratio of bank deposits to credit are non-stationary at their levels.

At the first difference, the results above show that we can reject the null hypothesis of the all the variables. All the variables are stationary at the first difference. This implies that all the variables are individually integrated of order one I(1)

4.3 COINTEGRATION RESULTS

Table 4: Cointegration Results

Variable	Trend	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Residual 1	Trend	-8.425	-3.628	-2.950	-2.608
Residual 1	No Trend	-3.599	-3.770	-3.283	-2.968

Source: Researcher's own tests using STATA

Note: All p-values are zero (0.0000)

The results presented above indicate that the ordinary least square (OLS) residuals have no unit roots with trend at 1% level of significance and without trend at 5% level of significance. The p-values also indicate the non-existence of unit roots at all levels of significance with and without trend for both residuals. This implies that the variables are cointegrated and, therefore, have a long-run relationship financial development and energy consumption.

4.4 REGRESSION RESULTS

Table 5: Regression Results

Variable	Equation 1	Equation 2
Financial Development (FD)		0.034477**
Energy Consumption (EC)	1.326974**	
Income	-0.3916087**	0.0950399**
Interest	-0.213635**	0.0019165
Price	0.1784438	-0.1113384*
Ratio of bank deposit to credit	0.6321598*	-0.413409
Lagged Financial Development (FDt-1)	-0.2680979**	
Lagged Energy Consumption (ECt-1)		0.969*
Constant	0.136944	0.0330842*
<hr/>		
N	43	43
R- Squared	0.4747	0.2765
Adjusted R-Squared	0.3872	0.1559
RMSE	0.06902	0.01394
F-Statistic	0.0004	0.0562

Source: Own computation using STATA

Asterik (*) = Significance at 1%; (**) = Significance at 5%; (***) = Significance at 10%

Where equation 1 is:

$$\ln FD_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln EC_t + \beta_4 \ln FD_{t-1} + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t$$

And equation 2 is:

$$\ln EC_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln FD_t + \beta_4 \ln EC_{t-1} + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t$$

From the regression table above, in the first equation (the financial development function), the coefficients of energy consumption, interest, and lagged financial development are statistically significant at 5% level of confidence. The coefficient of the ratio of bank deposit to credit is significant at 1% confidence level. On the other hand, the coefficient of price is not statistically significant. However, the overall significance test shows that all the coefficients are jointly significant with F-statistic probability of less than 0.05. The financial development function (equation 1) has an R^2 of 47.47% and adjusted R^2 of 38.72%. The coefficient of energy consumption shows a positive contribution to financial development. A 1% increase in energy consumption leads to an increase in financial development by about 1.3269%.

The energy consumption equation estimates shows that the coefficients of financial development, income, price, and lagged energy consumption are all statistically significant at 1%. However, the coefficients of interest and ratio of bank deposit to credit are not significant. Further, the sign of the interest coefficient is negative which is contrary to expected sign. The coefficient of financial development shows the sign as expected. A 1% increase in financial development leads to an increase in energy consumption by about 0.0345%.

4.5 GRANGER CAUSALITY TEST RESULTS

Based on the stationarity test results and the cointegration test results, both financial development and energy consumption are integrated of the first order (I(1)), are cointegrated, and have a long-run relationship. Nevertheless, they may be related in the short-run. Interactions in the short-run may be described by a VAR model in first differences. This is because the VAR model can be used to capture evolution and the interdependencies between multiple time series.

The VAR model is generally preferred because it is expected that the past values of financial development and energy consumption could have a significant impact on the current values.

The VAR model of one lag was used to estimate the variables of financial development and energy consumption. The VAR (1) model was estimated in the following form with all variables in first difference form and tests various hypotheses:

H_0 = Financial Development does not cause energy consumption or energy consumption does not cause Financial Development.

H_A = Financial Development causes energy consumption or energy consumption causes financial development

The results are as follows:

Table 6: Granger Causality Results

Dependent Variable: dlnFD			
Excluded	Chi-Sq	Prob. Value (Prob>Chi2)	Results
dlnEC	11.592	0.237	Do not reject H_0

Dependent Variable: dlnEC			
Excluded	Chi-Sq	Prob. Value (Prob>Chi2)	Results
dlnFD	17.745	0.038	Reject H_0

Source: Own computation through STATA

In the first Granger equation has a p-value of 0.237 which is greater than 10% (0.1). We, therefore, fail to reject the null hypothesis and conclude that financial development does not Granger-cause energy consumption.

Conversely, testing whether energy consumption Granger-causes financial development value dictates that we should reject the null hypothesis since the p-value of 0.038 is less than 5% (0.05). We can, therefore, conclude that there is causation running from energy consumption to financial development.

4.6 POST-ESTIMATION DIAGNOSTICS

4.6.1 Ramsey RESET Test

The study entailed a post-estimation diagnostic which was carried out in order to ascertain if the estimated model was properly specified. The Ramsey RESET test, which was based on the null hypothesis that a model has omitted variables against the alternative a model has no omitted variables was done. The table below reports the results from the Ramsey RESET Test.

Table 7: Ramsey RESET Test

F-STATISTIC	Probability
0.97	0.4187

Source: Author's Computations Using STATA

Table 7 indicates that the model has no omitted variables and it is well specified, as indicated by the p-value of 0.4187 at the 1%, 5% and 10% levels of significance.

4.6.2 Shapiro-Wilk Test for Normality

In order to ascertain the predictive accuracy of the model, a normality test of the residuals was carried out. The null hypothesis of the test is that of non-normality while the alternative hypothesis is normality. Below are the results from the residual normality test:

Table 8: Shapiro-Wilk Test for Normality

Shapiro-Wilk Test for Normality	
Shapiro-Wilk W Test	Probability Value
0.92427	0.00663

Source: Own Computation using STATA

From the results in table 8, the residuals from the model are not normally distributed as indicated by the probability value of 0.00663 which is less than the 0.05 significance level.

4.6.3 Breusch-Godfrey Serial Correlation LM Test

A test for autocorrelation of residuals was conducted using the Breusch-Godfrey Serial Correlation LM test which is based on the null hypothesis of no serial correlation against the alternative of serial correlation.

Table 9: Breush-Godfrey Serial Correlation LM Test

Breusch-Godfrey LM test for autocorrelation	
F-Statistic	Probability Value
0.171	0.6795

Source: Own computation using STATA

The results unambiguously indicate that the residuals of the model are not serially correlated with the variables as indicated by the p-value 0.6795 which is greater than the 0.05 level of significance.

4.6.4 Breusch-Pagan-Godfrey Test for Heteroskedasticity

Table 10: Breush-Pagan-Godfrey Test for Heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	
F-Statistic	Probability
1	0.3172

Source: Own computation on STATA

From the results, the p-value of 0.3172 which is greater than the 0.05 level of significance postulates that the residuals of the model have no heteroskedasticity.

4.6.5 Test for Multicollinearity

Table 11: Test Results for Multicollinearity-First Equation

Variable	VIF	1/VIF
dlnEC	1.32	0.759175
dlnINCOME	1.31	0.76411
DlnPRICE	1.46	0.683866
dlnINTEREST	1.03	0.975458
dlnBNKDVC	1.11	0.899169
Mean VIF	1.25	

Source: Own computation on STATA

Where equation 1 is:

$$\ln FD_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln EC_t + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t$$

Table 12: Test Results for Multicollinearity- Second Equation

Variable	VIF	1/VIF
dlnFD	1.71	0.584615
dlnINCOME	1.31	0.766052
DlnPRICE	1.17	0.854356
dlnINTEREST	1.07	0.935311
dlnBNKDVC	1.53	0.655285
Mean VIF	1.36	

Source: Own computation on STATA

Where equation 2 is:

$$\ln EC_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln FD_t + \beta_5 \ln BDVC_t + \beta_6 \ln i_t + u_t$$

Using the variance inflation factor, VIF, and a threshold of 10, the results show that the variables are not collinear and this can also be seen in the tolerance levels, all of which are greater than 0.1.

CHAPTER FIVE

5 SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 INTRODUCTION

This chapter gives a brief summary of the study and the conclusions drawn. It provides the policy outcomes of the study and recommendations. It also outlines the study's limitations and highlights areas for further research.

5.2 SUMMARY OF THE STUDY

This study examined the relationship between financial development and energy consumption in Kenya for the period including and between 1970 and 2014. Energy consumption was measured in nominal terms by total energy consumption (kg of oil equivalent). Financial development was proxied by the ratio of domestic credit to private sector as a share of GDP as recommended by Levine (2003).

With the financial development and energy consumption as the two dependent variables and as independent variables for each other, the independent variables included income, price, interest rate, ratio of bank deposits to credit, lagged financial development, and lagged energy consumption.

Pre-estimation tests and statistical, descriptive and graphical analyses were employed and in addition, time series properties of the variables were established using the ADF unit root test. The ADF test showed that all the variables were non-stationary at levels but stationary at the first difference at the 1%, 5% and 10% levels of significance. Co-integration test was also carried out and showed that financial development and energy consumption are co-integrated, implying that they have a long-run relationship.

This study's empirical model was estimated through regression, for both equations. The findings show that energy consumption, price and the ratio of bank deposit to credit all have a positive impact on financial development. Further, the results reveal that income, interest, and lagged financial development have a negative impact on financial development. With regards to energy consumption, the findings indicate that price and the ratio of bank deposit to credit have a negative impact on energy consumption while financial development, income, interest, and lagged energy consumption all have a positive impact on energy consumption.

The causality between financial development and energy consumption was tested using the Granger Causality test. The Granger Causality test showed that financial development does not Granger-cause energy consumption and that energy consumption Granger-causes financial development with a 5% level of significance.

Various post estimation diagnostic tests were carried out. These reveal that the model was well specified as reported by the Ramsey RESET, the residuals from the model were normally distributed and the model showed signs of outliers in the residuals as reported by Shapiro-Wilk W Test. The residuals from the model also had no serial correlation as reported from Breusch-Godfrey Serial correlation LM test and the residuals from the model were homoskedastic, as reported by Breusch-Pagan-Godfrey test.

5.3 CONCLUSION

The Granger Causality results revealed that financial development does not Granger-cause energy consumption and that energy consumption Granger-causes financial development with a 5% level of significance. This implies that financial development is determined by energy

consumption. It implies that a decline in energy consumption may negatively affect financial development and consequently lead to poor economic performance.

These results are consistent with the findings of two studies done by Mulali and Sab (2012). In their first study, they tried to examine the dynamic relationship between energy consumption, income, financial development, and CO₂ emissions by incorporating investment and employment as potential determinants of domestic production in Sub-Saharan African countries. They concluded that a rise in energy consumption adds to demand of financial services which subsequently leads to an increase the improvements in environmental quality by controlling CO₂ emissions through the implementation of well-organized and transparent financial policies. Their results implied that energy consumption Granger-causes financial development. A subsequent study conducted by Mulali and Sab (2012b) consisting of 19 developed and developing countries and found the same results as of Granger causality running from energy consumption to financial development.

5.4 POLICY IMPLICATIONS AND RECOMMENDATIONS

The energy consumption to financial development direction of causality is an eye-opener to the Kenyan government to direct its measures and policies towards improving and encouraging energy consumption by households and firms. Such policies would lead to increased financial development and consequently increase Kenya's economic growth.

Such measures and policies may include developing the appropriate infrastructure and market structure for supplying energy, strengthening the regulatory and institutional framework, including its pricing and competition policies.

More specifically, the government of Kenya can further subsidize the cost of energy, especially electricity and develop better infrastructure (power lines and petroleum products pipelines) for energy distribution which may involve privatization of some functions for efficiency and effectiveness.

5.5 LIMITATIONS OF THE STUDY

The main limitation of this study is the use of a proxy to measure financial development. Various studies have used different proxies for financial development leading to results not being comparable. This is the main reason for no consensus being reached regarding the causality relationship between financial development and energy consumption. The minor limitation of this study is the inconsistency of the different websites and publications with regards to data.

5.6 AREAS FOR FURTHER STUDY

Energy consumption plays a key role as an element of financial development. Therefore, further research should be done focusing on the exact mechanism by which it influences economic growth. In relation to this, further studies should include other indicators of financial development used in the literature to possibly provide better results about the causality relationship between energy consumption and financial development

REFERENCES

- Andae, G. (2014, July 27). *Money Markets*. Retrieved January 31, 2015, from Business Daily Africa: <http://www.businessdailyafrica.com>
- Bagehot, W. (1873). *Lombard Street: A Description of the Money Market*. In A. Khan (Ed.), *Business Review*. Philadelphia: Federal Reserve Bank of Philadelphia
- Bennoit, K. (2011, March 17). *Linear Regression Models with Logarithmic Transformations*. London, London School of Economics, United Kingdom: Methodology Institute.
- Bhattacharyya, S. C., & Timilsina, G. R. (2009). *Energy Demand Models for Policy Formulation: A Comparative Study of Energy Demand Models*. Washington DC: The World Bank Group.
- CBK. (2014, December 13). <https://www.centralbank.go.ke/>. Retrieved February 2, 2015, from Central Bank of Kenya:
<https://www.centralbank.go.ke/images/docs/BankSupervisionReports/CommercialBanksDirectory-13December2014.pdf>
- Chtioui, S. (2012). Does economic growth and financial development spur energy consumption in Tunisia? *Journal of Economics and International Finance*, 4(7), 150-158.
- Dan, & Lijun. (2009). Financial development and energy consumption: an empirical research based on Guangdong Province. *International Conference on Information Management, Innovation Management and Industrial Engineering*, 3, pp. 102-105. Beijing: ICIII.
- Dickey, D. & Fuller, W. (1981). Likelihood ratio statistics for auto-regressive time series. *Econometrica*, 49, 1057-1072.

Engle, R., & Granger, R. (1987). Co-integration and Error Correction: representation, estimation, and testing. *Econometrica*, 55, 251-276.

Gachiri, J. (2013, February 26). *Money Markets*. Retrieved January 31, 2015, from Business Daily Africa: <http://www.businessdailyafrica.com>

Granger, C. (1986). Developments in the study of cointegrated economic variables. *Oxford Bulletin of Economics and Statistics*, 48(3), 213-228.

Greenwood, J., & Jovanovic, B. (1990). Financial development, growth, and the distribution of income. *Journal of Political Economy*, 98, 1076-1107.

Gujarati, D. N. (2004). *Basic Econometrics* (Fourth ed.). New York: The McGraw–Hill Companies.

Hicks, J. R. (1969). Automatists, Hawtreyans, and Keynesians. *Journal of Money, Credit and Banking*, 1(3), 307-317.

Huang, Y. (2010). *Determinants of Financial Development*. Hampshire, UK: Palgrave Macmillan.

International Energy Agency. (2013). *International Energy Outlook 2013 With Projections to 2040*. Washington DC: U.S. Energy Information Administration.

International Energy Agency. (2014). *Key World Energy Statistics*. Paris, France: International Energy Agency.

- Islam, F., Shahbaz, M., & Alam, M. (2011). Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis. *Munich Personal RePEc Archive*, 28403, 2-17.
- Jaffe, D., & Levonian, M. (2001). Structure of banking systems in developed and transition economies. *European Financial Management*, 7(2), 161-181.
- Kakar, Z. K., Khilji, B. A., & Khan, M. J. (2011). Financial Development and Energy Consumption: Empirical Evidence from Pakistan. *International Journal of Trade, Economics and Finance*, 2(6), 469-471.
- Karanfil, F. (2009). How many times again will we examine the energy–income nexus using a limited range of traditional econometric tools? *Energy Policy*, 36, 3019-3025.
- Levine, R. (2003). More on Finance and Growth: More Finance, More Growth? *The Federal Reserve Bank of St. Louis.*, 31-46.
- Levine, R. (2005). Finance and growth: Theory and evidence. In A. Philippe, & S. Durlauf (Edt.) *Handbook of Economic Growth*. Amsterdam: Elsevier Science
- Love, I., & Zicchino, L. (2006). Financial development and dynamic investment behaviour: Evidence from panel VAR. *The Quarterly Review of Economics and Finance*, 46(2), 190-210.
- McKinnon, R. I. (1973). *Money and Capital in Economic Development*. Washington D.C.: Brookings Institution.
- Mulali, U. A., & Sab, C. (2012(a)). The Impact of Energy Consumption and CO2 Emission on the Economic Growth and Financial Development in the Sub Saharan African Countries. *Energy Policy*, 39, 180-186.

- Mulali, U. A., & Sab, C. (2012(b)). The Impact of Energy Consumption and CO2 Emission on the Economic and Financial Development in 19 Selected Countries. *Energy Reviews*, 16, 4365–4369.
- Muli, A. (2008, July). Financial development and economic growth in Kenya: An empirical analysis. Nairobi, Nairobi, Kenya.
- Odhiambo, N. M. (2008). Financial Development in Kenya: a Dynamic Test of the Finance-led Growth Hypothesis. *Economic Issues*, 13(2), 21-36.
- PWC. (2013). *Oil and Gas in Africa*. Johannesburg: Price and Waterhouse Coopers.
- Sadorsky. (2010). The Impact of Financial Development on Energy Consumption in Emerging Economies. *Energy Policy*, 38(25), 2528–2535.
- Sadorsky, P. (2011). Financial development and energy consumption in Central and Eastern European frontier economies. *Energy Policy*, 39, 999-1006.
- Saint-Paul, G. (1992). Technological Choice, Financial Markets and Economic Development. *European Economic Review*, 36, 763-781.
- Salmanai, D. M., & Atyab, E. M. (2014). What is the role of Financial Development and Energy Consumption on Economic Growth? New Evidence from North African Countries. *International Journal of Finance & Banking Studies*, 137-149.
- Schumpeter, J. A. (1911). *The Theory of Economic Development*. Cambridge MA: Harvard University Press.

Shahbaz, M., & Lean, H. H. (2012). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. *Energy Policy*, 40, 473-479.

Shahbaz, M., & Lean, H. H. (2012). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. *Energy Policy*, 40, 473-479.

Shaw, E. (1973). *Financial Deepening in Economic Development*. New York: Oxford University Press.

Tang, C. (2009). Electricity consumption, income, foreign direct investment, and population in Malaysia: new evidence from multivariate framework analysis. *Journal of Economic Studies*, 36, 371-382.

Tang, C., & Tan, E. (2012). The linkages among energy consumption, economic growth, relative price, foreign direct investment, and financial development in Malaysia. *Quality and Quantity*, DOI10.1007, 02-04.

Tullow Oil. (2013). *Strategic Report*. London, United Kingdom: Black Sun Plc.

Yang, H. (2000). A note on the causal relationship between energy and GDP in Taiwan. *Energy Economics*, 22, 309-317.

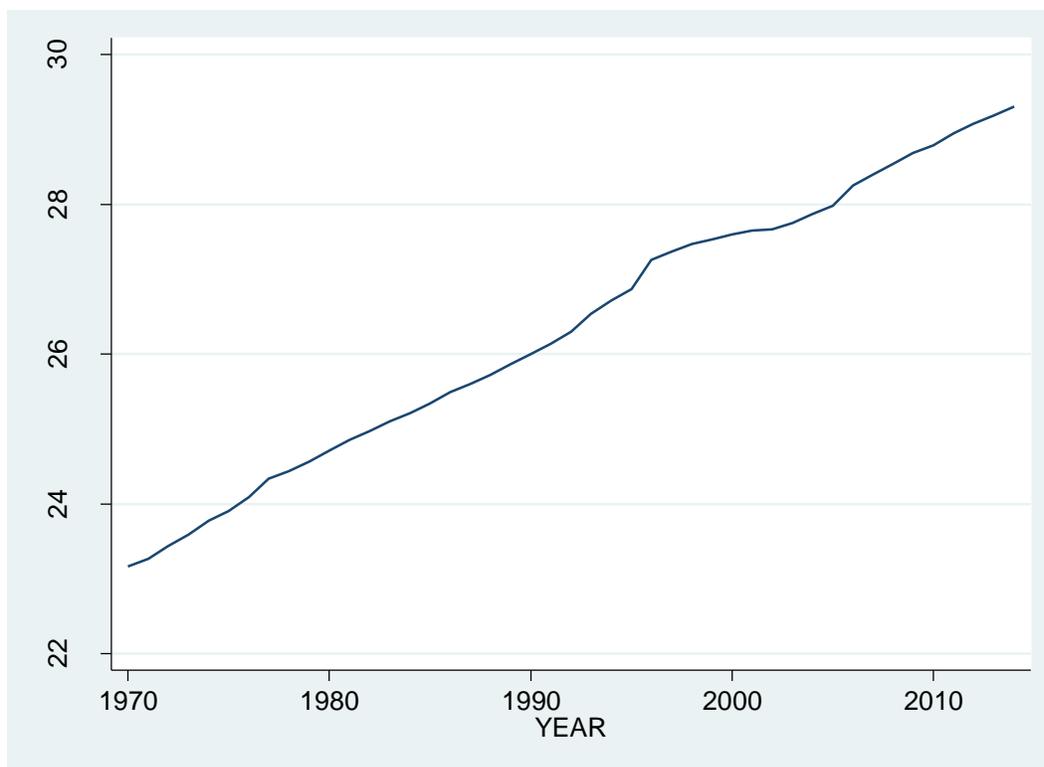
APPENDICES

Appendix 1: Correlation Matrix

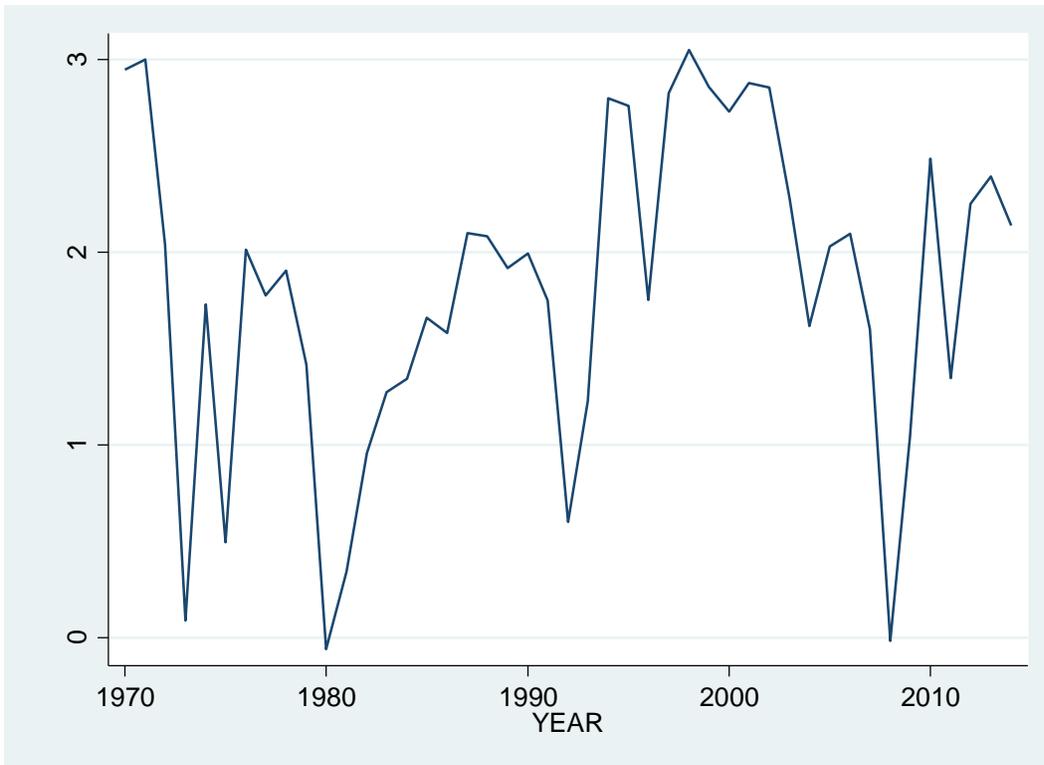
	dlnFD	dlnEC	dlnINC~E	dlnINT~T	dlnPRICE	dlnBNK~C
dlnFD	1.0000					
dlnEC	-0.0348	1.0000				
dlnINCOME	-0.3492	0.1869	1.0000			
dlnINTEREST	-0.1963	0.0486	-0.0776	1.0000		
dlnPRICE	-0.1491	-0.3283	0.3465	0.0114	1.0000	
dlnBNKDVC	0.5712	-0.1306	-0.1966	-0.0957	-0.2099	1.0000

Appendix 2: Trends of Independent Variables

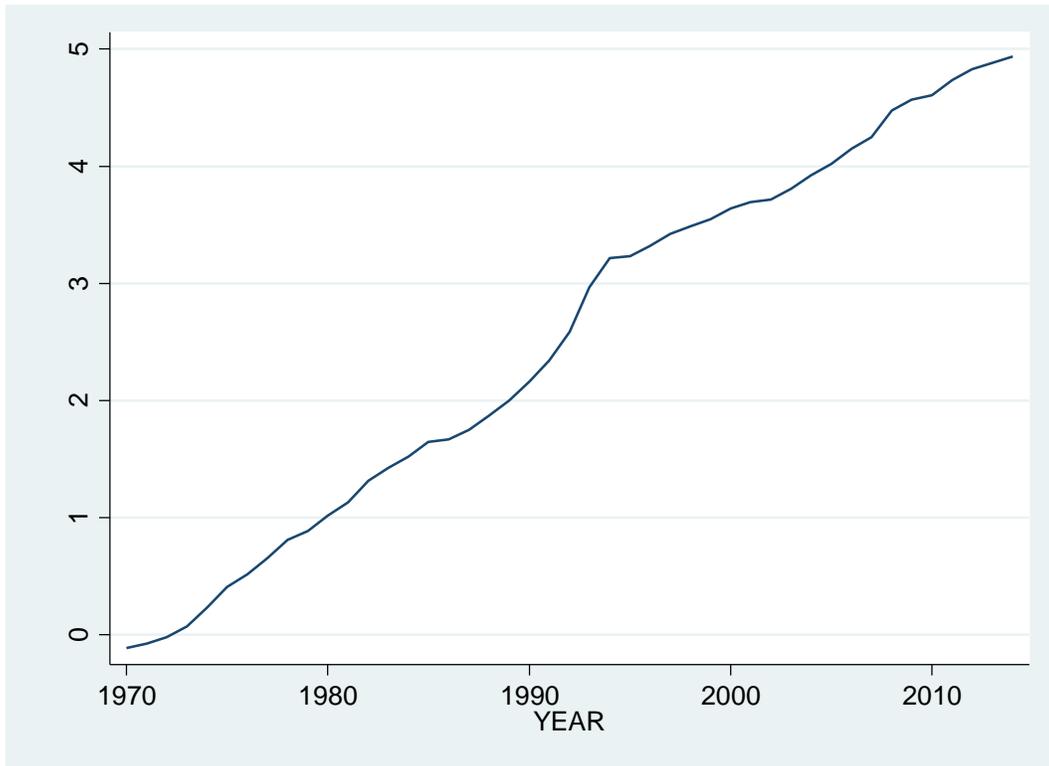
a) Trend of Income



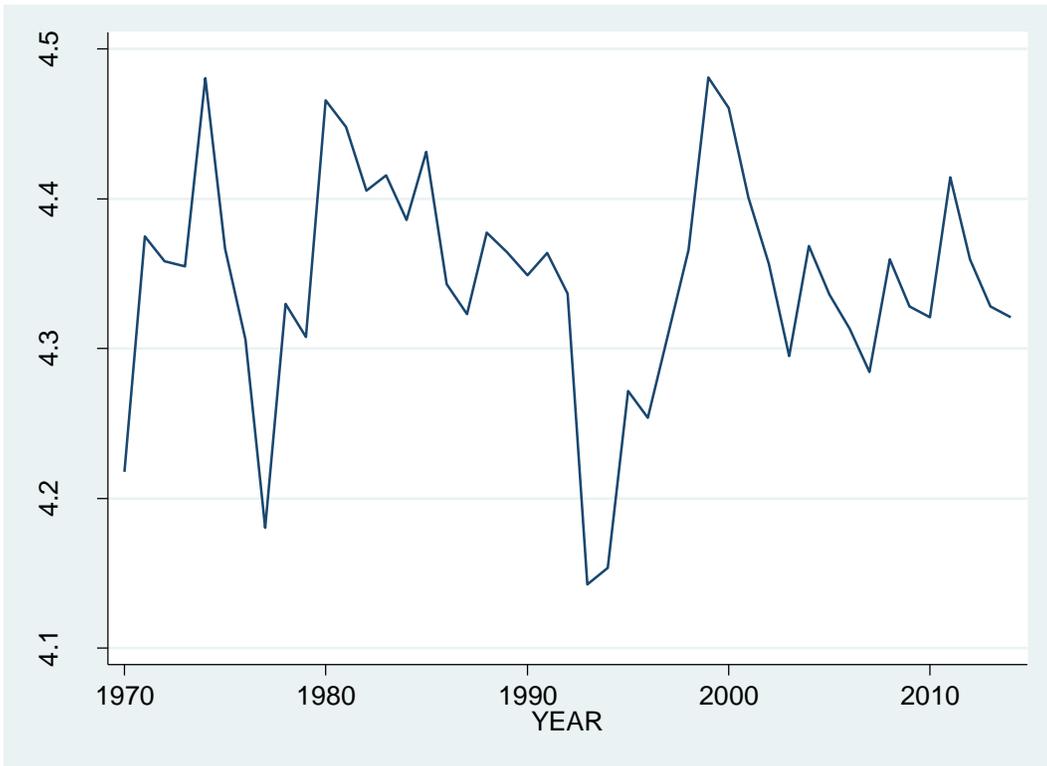
b) Interest Trend



c) Price Trend



d) Trend of the ratio of bank deposits to credit



Appendix 3: Raw Data

YEAR	Financial Development	Energy Consumption	INCOME_GDP	INTEREST	PRICE_CPI	Bank Deposit to Credit Index
1970	15.11892	5189.282922	11,453,200,000.00	19.06939	0.892816	67.87979
1971	17.43254	5283.787	12,702,800,000.00	20.06939	0.926566	79.43253
1972	16.48605	5525.681	15,052,000,000.00	7.701927	0.9806	78.11552
1973	21.94467	5673.635	17,566,000,000.00	1.092377	1.071612	77.86526
1974	21.94334	5889.453	21,214,000,000.00	5.643527	1.262465	88.29371
1975	21.75921	6034.437	23,934,000,000.00	1.640906	1.503851	78.78727
1976	21.67505	6328.98	29,072,000,000.00	7.490084	1.676027	74.14199
1977	22.27163	6643.012	37,198,000,000.00	5.902336	1.924431	65.38303
1978	27.58019	6844.21	40,994,600,000.00	6.712202	2.250271	75.93753
1979	27.27081	7092.548	46,604,000,000.00	4.128561	2.429828	74.27075
1980	29.48393	7358.01	53,910,002,000.00	0.942589	2.766558	86.99744
1981	29.40222	7567.303	62,016,000,000.00	1.410506	3.087563	85.45627
1982	29.98922	7709.076	70,247,800,000.00	2.605412	3.725661	81.8855
1983	29.34711	7846.958	79,592,200,000.00	3.572394	4.150304	82.71502
1984	30.55453	8304.259	89,242,600,000.00	3.83512	4.577126	80.30667
1985	31.52554	8666.265	100,811,600,000.00	5.257538	5.172452	84.03249
1986	30.25714	9443.966	117,460,200,000.00	4.864495	5.303537	76.93135
1987	28.95267	9836.827	131,155,800,000.00	8.15739	5.761639	75.40882
1988	30.8323	10085.168	148,283,780,000.00	8.026232	6.468302	79.62277
1989	31.38105	10455.044		6.815212	7.360236	78.6015

			170,404,100,000.00			
1990	32.66793	10675.095	196,433,610,000.00	7.332797	8.66902	77.40809
1991	33.7477	10869.019	224,230,069,300.00	5.745513	10.41015	78.56838
1992	34.84057	11146.269	264,471,872,700.00	1.825329	13.25549	76.46098
1993	29.20755	11414.594	333,611,292,400.00	3.413472	19.35021	62.96727
1994	29.27054	11559.781	400,657,837,200.00	16.42811	24.92586	63.66725
1995	34.54683	12104.962	465,250,740,000.00	15.80165	25.31329	71.62349
1996	26.97199	12538.006	687,998,000,000.00	5.776589	27.55708	70.3604
1997	27.94232	12696.958	770,313,000,000.00	16.87957	30.68807	74.44377
1998	27.33943	13189.506	850,808,200,000.00	21.09633	32.75106	78.73374
1999	29.25741	13502.773	906,927,630,000.00	17.45405	34.63163	88.31358
2000	28.43035	14055.299	967,836,930,000.00	15.32743	38.08787	86.53915
2001	25.2196	14258.528	1,020,221,000,000.00	17.8125	40.27358	81.50346
2002	25.86324	14453.555	1,035,373,000,000.00	17.35814	41.06347	77.99787
2003	24.60027	14769.104	1,131,782,000,000.00	9.770511	45.09413	73.32689
2004	26.79153	15551.587	1,274,329,000,000.00	5.045258	50.33589	78.93704
2005	25.93183	16151.068	1,415,725,000,000.00	7.609988	55.52692	76.42086
2006	26.07599	16896.43	1,862,041,000,000.00	8.132433	63.55264	74.69681
2007	26.92718	17229.685	2,151,349,000,000.00	4.958936	69.75466	72.5416
2008	29.90402	17805.569	2,483,058,000,000.00	0.984997	88.05816	78.23703
2009	30.27231	18896.663	2,863,688,000,000.00	2.837078	96.18956	75.79092
2010	33.79173	19719.226	3,169,335,000,000.00	12.02823	100	75.26713
2011	37.3618	20178.939	3,726,052,000,000.00	3.848269	114.0215	82.62142
2012	37.4322	20853.3987		9.513982	124.7149	78.23703

			4,254,772,000,000.00			
2013	38.9873	22131.25835	4,757,532,000,000.00	10.94165	131.8465	75.79092
2014	39.06076	23094.62179	5,319,700,028,820.35	8.5	139.3858	75.26713