Approval of the thesis

Declaration

YAKIN DOĞU ÜNİVERSİTESİ
NEAR EAST UNIVERSITY
SOSYAL BİLİMLER ENSTİTÜSÜ
GRADUATE SCHOOL OF SOCIAL SCIENCES

Date: ...../...../......, Nicosia

Declaration

Type of Thesis: Master ☐ Proficiency in Art ☐ **PhD** ☐

STUDENT NO: **20144726**

PROGRAME: **PhD Banking and Finance**

I **FAISAL** hereby declare that this dissertation entitled "**Financial deepening, electricity consumption, urbanization, trade and economic growth nexus in Iceland: An empirical evidence from time series analysis"** has been prepared myself under the guidance and supervision of **"Associate Professor Dr.Turgut Tursoy"** in partial fulfilment of The Near East University, Graduate School of Social Sciences regulations and does not to the best of my knowledge breach any Law of Copyrights and has been tested for plagiarism and a copy of the result can be found in the thesis.

Signature: ___________________________________

ACKNOWLEDGEMENT

I would like to thank my supervisor Associate Professor Dr Turgut TURSOY for his continuous guidance, support, motivation, enthusiasm, and immense knowledge in the preparation of this thesis. His guidance helped me in all the time of research and writing of this thesis. I would also like to thank my co-supervisor Assistant Professor Dr. Nil GUNSEL RESATOGLU for her support and encouragement during my studies. As it would not be possible to accomplish my target on time without their continuous guidance, motivation and support. I am much oblige. I am also much grateful and thankful to Miss.Ozlem Ercantan for assisting me in translating the abstract to Turkish language.

I would like to pay special thanks to my parents, parents in law and whole family members for their invaluable support during my studies. Last, but not the least I am much thankful to my loving and caring wife who supported and encouraged me in all the challenging time of studies. I owe a lot to her for her endless support, it would not be possible to overcome the most difficult times during my studies without her support.

DEDICATION

*In the memory of my beloved Shaheed uncle **"Muhammad TARIQ**"*

You are always missed "Khandage"

I came into this life
you held me in your arms
you kept me safe
so no one could harm

You taught me values
Lessons in life I would learn
you taught me to respect
I gave you love in return

You have always been in my life
through thick and thin
and now my lonely journey
without you will begin

For you were my hero
forever and a day
you will always remain that hero
till I meet you again some day

I will embrace you in my arms
and hold on tight
I will stand by your side
and you will never leave my sight

I miss you so much
the pain does not ease
I pray you are happy
and finally at peace

ABSTRACT

This thesis investigates the role of urbanisation, financial deepening, economic growth, capital and trade by considering the time series data from 1965-2013. This thesis applied the Perron and Vogelsang (1992) that accounts for one endogenous structural break to determine the order of integration in addition to the conventional unit root tests. The ARDL bounds test of cointegration is applied to analyse the cointegration among the estimated variables. The results of cointegration confirm the evidence of a long-run relationship. Furthermore, the long-run and short-run elasticities are determined under the framework of an ARDL approach. The findings confirmed that trade, capital, financial deepening, urbanisation has a positive and significant impact on electricity demand in the long-run. Furthermore, the squared term of financial Deeping is investigated to analyse its impact on electricity consumption. The study found an inverted U-shaped relationship between financial Deeping and electricity consumption but insignificant in the export model in long-run.

However, the thesis found an existence of a significant inverted U-shaped relationship between financial Deeping and electricity consumption in import and trade openness model in the short-run.

Furthermore, the VECM model under the ARDL framework along with variance decomposition to investigate the direction of causality. The results of the variance decomposition are robust to those obtained from VECM Granger causality test. The NARDL also confirms the evidence of cointegration among the estimated variables. Finally, the Hatemi-J (2012) causality test is applied to investigate the asymmetric and the symmetric causal relationship among the variables.

In the second section, this thesis empirically investigates the relationship between electricity consumption, economic growth, urbanisation and trade in Iceland, covering the period from 1965 to 2013. This empirical relationship was analysed using the ARDL bounds testing approach to cointegration. Secondly, the causality was investigated among the variables using Granger causality under the VECM framework. The ARDL bounds testing approach to cointegration confirms a long-run relationship between electricity consumption and its regressors. The empirical estimation indicates the existence of a positive and statistically significant impact of economic growth, trade and urbanisation on electricity consumption for Iceland, not only in the long run but also in the short run. Furthermore, electricity consumption converges to its long-run position by 45.63% speed of adjustment using the channels of urbanisation, trade, and economic growth.

The results of the Granger causality suggest the evidence of a feedback causal relationship between urbanisation and electricity consumption in the long-run, thus validating the feedback hypothesis. However, economic growth is causing trade thus validating the growth-led trade hypothesis in the short run. Additionally, no causal relationship was found between electricity usage and economic growth, which confirms the neutrality hypothesis. Implementing the energy conservation policy in this regard will have no damaging effect on economic growth for Iceland.

Furthermore, the government should consider the economic stages (situations) while formulating and implementing their energy policies and energy conservation measures.

Key words: Electricity consumption, urbanisation, ARDL, trade, Financial Deepening

ÖZET

BU tez 1965-2013 yılları arasındaki dataları kullanarak,kentleşmenin,finansal derinleşmenin,ekonomik gelişimin,sermayenin ve ticaretin rolünü araştırmaktadır.BU tez, entegre sırasına ve ek olarak konvansiyonel kök birim teslerine karar vermek için iç kaynaklı yapısal kırılımı hesaplayan Perron ve Vogelsang ‘ı uygulamıştır. ARDL sınırlı koentegrasyon testi tahmini değişkenler arasındaki koentegrasyonu analiz için uygulanır.Koentegrasyon sonuçları uzun vadeli ilişkilerin delilini onaylar.Dahası, uzun vadeli ve kısa vadeli esneklikler ARDL yaklaşımının çerçevesinde karar verilir.Bulgular, onaylar ki ticaret,sermaye , finansal derinleşme,kentleşmenin uzun vadede elektriksel talep üzerine positif ve önemli etkisi vardır .Ayrıca,işaretli term olan finansal DERİNLEŞME ‘nin elektriksel tüketim üzerine etkisini analiz etmek için araştırıldı.Araştırmada, finansal derinleşme ve elektrik tüketimi arasındaki ilişkideki ters çevrilmiş U şekli bulundu fakat uzun vadede de önemsiz bir export modelidir.

Ancak, tez finansal Derinleşme ve ithalattaki ve kısa vadeli ticaret açığı modelindeki elektriksel tüketim arasında tersine U şekilli önemli bir ilişkinin varlığını bulmuştur.

Ayrica,VECM MODEL tahmini degiskenleri yonetmeyi arastirmada uygulanmistir. Varyans dağılım sonuçları , VECM Granger causality testten elde edilenlere direnç göstermektedir.NARDL tahmini değişkenler ve koentegrasyon arasındaki delili onaylamaktadır.Sonuç olarak, Hatemi-J(2012) causality testi asimetrik ve simetrik değişenler arsındaki sebepsel ilişkiyi araştırmak için uygulanmaktadır.

İkinci aşamada,bu tez deneysel olarak, 1965-2013 yılları arasındaki elektriksel tüketim,ekonomik gelişim,kentleşme ve İzlandadaki ticaret arasındaki ilişkiyi araştırmaktadır.Bu deneysel ilişki ARDL sınırlı test yaklaşımı kullanarak analiz edilmiştir.İkinci olarak, VECM çerçevesi altında Granger causality kullanarak , değişimler arasındaki causality araştırılmıştır.ARDL sınırlı koentegrasyonel test yaklaşımı uzun vadeli elektriksel tüketim ve regresörleri arasındaki ilişkiyi onaylamaktadır.Deneysel tahmin, positif ve istatiktiksel önemli ekonomik gelişim, ticaret ve kentleşmenin uzun ve kısa vadede İzlandadaki elektriksel tüketime olan etkisinin varlığını göstermektedir.Diğer taraftan, elektriksel tüketim uzun vadedeki pozisyonunu kentleşme,ticaret ve ekonomik gelişim kanallarını kullanarak %45.63 hızla korumaktadır.

Granger causality sonuçları , kentleşme ve uzun vadedeki elektiksel tüketim arasındaki geri dönüşüm sebepsel ilişkiyi ifade etmektedir, ki buda geri dönüşüm hipotezini doğrulamaktadır. Fakat,ekonomik gelişim ticareti etkiler.İlave olarak,elektrik kullanımı ve ekonomik gelişim arasında nötrlük hipotezini doğrulayan sebepsel bir ilişki bulunamamıştır.

Anahtar kelimeler: Elektrik tüketimi, kentleşme, ARDL, ticaret, finansal derinleşme

TABLE OF CONTENTS

Approval of the thesis i

Acknowledgement iii

Dedication iv

Abstract v

Özet vii

Table of contents ix

List of tables xi

List of figures xiii

List of abbreviations xiv

1. INTRODUCTION 1

1.1 Identification of Research question 2

1.2 MOTIVATION OF THE STUDY 2

2. ECONOMY OF ICELAND; AN OVERVIEW 6

2.1. Introduction 6

2.2. Foreign trade in Iceland 6

2.3. Electricity sector 7

2.4. Financial Sector in Iceland 8

2.5. Urbanisation in Iceland 8

3. LITERATURE REVIEW 9

3.1 Financial development (FD) and Electricity consumption (EC) 9

3.1. Electricity Consumption and Economic Growth 11

3.2. Urbanisation and Electricity consumption 12

4. THEORETICAL FRAME WORK AND ECONOMETRIC METHODOLOGY 15

4.1 Theoretical Framework 15

4.2 Econometric Methodology 21

4.3 Non-linear ARDL 26

4.4 Asymmetric causality test 27

5 EMPIRICAL RESULTS AND DISCUSSION 30

5.1 Unit Root test Results 30

5.2 ARDL long-run results and Short-run Results 33

5.3 VECM Causality results 42

5.4 NARDL Cointegration results 49

6. ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH: EMPERICAL EVIDENCE FROM ICELAND 62

6.1 Introduction 62

6.2 Literature review 64

6.3 Methodology of the study 67

6.3.1 Data 67

6.3.2 Model specification and econometric methodology 67

6.4 Model stability and diagnostic tests: 68

6.5 Empirical Results and Analysis 70

6.5.1 Unit Root Test for Stationarity 70

6.6 Granger Causality results 75

7 CONCLUSION AND POLICY IMPLICATIONS 77

References 80

Appendix 1 90

Appendix 2. list of publications during Ph.D. 91

LIST OF TABLES

Table 4.1.Construction of financial development indicator based on the banking sector development variables 18

Table 4.2.Principal Component Analysis for financial development using Banking sector 18

Table 4.3.Definition variables along with their measurements used in the study 19

Table 5.1.ADF unit root test 30

Table 5.2.PP Unit root test 30

Table 5.3.KPSS unit root test 31

Table 5.4.Unit root test with one Endogenous Structural Break 31

Table 5.5.Results of Bounds test of Co-integration with long-run diagnostic tests. 34

Table 5.6.ARDL Long-run results (Linear and Non-linear) 36

Table 5.7.ARDL Short-run results (Linear) 39

Table 5.8.ARDL Short-run results (Non-linear) 40

Table 5.9. Granger causality test results using import as proxy for trade openness. 43

Table 5.10.Granger causality test results using export as proxy for trade openness. 44

Table 5.11.Granger causality test results using trade as proxy for trade openness. 45

Table 5.12.VD for imports as an indicator of TO 46

Table 5.13.VD for export as an indicator of TO 47

Table 5.14.VD for trade as an indicator of TO 48

Table 5.15.NARDL Cointegration results using Imports to measure the trade openness 50

Table 5.16.Long-run coefficients and Asymmetry tests using Imports to measure the trade openness 51

Table 5.17.NARDL Cointegration results using export to measure the trade openness 53

Table 5.18.Long-run coefficients and Asymmetry tests using export to measure the trade 54

Table 5.19.Long-run coefficients and Asymmetry tests using trade to measure the trade openness 56

Table 5.20.Long-run coefficients and Asymmetry tests using trade to measure the trade openness 57

Table 5.21.Asymmetric and non-Asymmetric (Symmetric) causal Results 58

Table 6.1.Literature Review 65

Table 6.2.ADF Unit root test 70

Table 6.3.PP Unit root test 70

Table 6.4.KPSS Unit root test 71

Table 6.5.Results of the Bounds test of Co-integration 71

Table 6.6.ARDL Long-run and short-run results 72

Table 6.7. Diagnostic Tests (Long run) 74

Table 6.8.Diagnostic Tests (Short run) 74

Table 6.9.Results of Granger Causality Tests 75

LIST OF FIGURES

Figure 5.1.LEC, LGDP, LIMPO, LURP,LFD, LKP represents electricity consumption, real GDP per capita, imports per capita, urbanisation, financial development, and Gross fixed capital respectively. 52

Figure 5.2.LEC, LGDP, LEXPO, LURP,LFD, LKP represents electricity consumption, real GDP per capita, exports per capita, urbanisation, financial development, and Gross fixed capital respectively. 55

Figure 5.3.LEC, LGDP, LTRP, LURP,LFD, LKP represents electricity consumption, real GDP per capita, trade per capita, urbanisation, financial development per capita, and Gross fixed capital per capita respectively ... 57

Figure 6.1.Stability tests using CUSUM. The blue line lies between the two red lines at 5% significance level, implying the stability of both long-run and short-run coefficients. 75

LIST OF ABBREVIATIONS

ARDL	Auto regressive distributed lag model
ADF	Augmented Dickey-Fuller Unit Root test
PP	Philips-Perron unit root test
KPSS	Kwiatkowski-Philips-Schmidt-Shin Unit Root test
PCM	Principal Component method
CUSUM	Cumulative sum
CUSUMsq	Cumulative sum square
NARDL	Non-linear autoregressive distributed lag model
VECM	Vector-error correction model
EK	Electricity consumption
HFF	House Financing Fund
BMS	Broad money supply
DCB	Domestic credit provided by the banking sector
DCF	Domestic credit provided to the economy by the financial sector
DCP	Domestic credit to the private sector
FD	Banking sector development index
MWh	Megawatt hours
GWh	Gigawatt hours
OECD	The Organisation for Economic Co-operation and Development
EKC	Environmental Kuznets curve
ECT	Error correction term
URB	Urbanisation
TR	Trade
VD	Variance decomposition

VAR	Unrestricted Vector auto regressive
AO	Additive outlier model
FD	Financial Deepening index
EC	Electricity consumption
DV’s	Dependent variables
VD	Variance decomposition
TO	Trade openness
IO	Innovative outlier
GCC	Gulf Cooperation Council

CHAPTER ONE

1. Introduction

At the end of the Second World War, there was a growing demand for better infrastructure and energy consumption by most of the advanced economies. This can only be achieved through rapid industrialisation and technological advancement by increasing and maintaining the momentum of higher economic growth in order to restore the economies. These reasons have subsequently induced the developed and the developing economies to demand more energy in the second half of the 20th century (Khraief et al. 2016). Electricity infrastructure is one of the important foundation of not only for developed but also for the developing countries. Electricity infrastructure has contributed to the economies not only by providing the employment opportunities to them but also it is believed to have a greater potential in supporting and contributing to the economic activity. Over the few decades, this has led to upsurge the demand for the electricity consumption, as electricity is considered to be the cleanest and efficient sources of energy for both the economies.

To the best of our knowledge, the current energy literature is scarcely pertaining to the studies based on the nexus between financial developments and electricity consumption in the presence of urbanisation and trade. It is important to understand the role of financial development in the economy. The improved financial development facilitates the economy by promoting the stock market and banking sector of the economy by attracting more foreign direct investment (FDI), advancing credits to the deficit economic unit, thus improving the economic efficiency of the country that will cause an upsurge in the demand for energy consumption. Karanfil (2009) argued in his study that the energy demand function may further be augmented by adding financial development and other important determinants in order to know the determinants of demand for energy. In this regard, Sadorsky (2010) conducted a study for 22 countries by analysing the relationship between energy consumption and financial development. Their study reported a positive and significant impact of financial development on EC. Moreover, it was further observed in his study, that the impact of the stock market variable is more as compared to the banking sector in effecting the energy demand for the emerging economies. In another study conducted by Sadorsky (2011) that investigated energy consumption and financial development nexus for 9 frontiers economies. The findings of his study suggested that financial development effects energy consumption positively. However, in this case, the banking variable that is used to measure the financial development has got more effect on energy consumption as compared to the bank variables. In a similar fashion, many studies have reported the nexus between FD and EC that have been explained in the literature review section. However, the results of countries are mixed for various economies.

1.1 Identification of Research question

An adequate amount of literature on the linkage between financial developments with the energy consumption is available. However, the literature on the empirical linkage between financial development and electricity demand for OECD countries appears to be scanty. Furthermore, in most of the studies from the literature[1] suggests that they are relying on one financial indicator as a measure of the financial deepening. This study analyses the linkage of financial development and electricity consumption by creating the index of bank proxies which has been missing in the previous studies based on available literature. In the light of the above discussion, the research question needs to be answered. Whether financial development can cause an upsurge in the electricity demand in Iceland using trade, urbanisation, economic growth and capital as the determinant of the electricity demand function? Since to the extent of our knowledge, no study has investigated the relationship between electricity consumption and financial development by using capital together with trade and electricity urbanisation as an additional determinant of electricity consumption. Furthermore, this study will also analyse the role of financial deepening by analysing the non-linear relationship and asymmetric causal relationship among the estimated variables as identified in the modelling section of the thesis.

1.2 Motivation for the Study

The significant contribution of output by the manufacturing sector has made Iceland one of the massive consumption of electricity compared with the rest of the world. The source of electricity production in Iceland is predominantly from hydroelectric and geothermal energy sources. These sources represent almost 73% electricity production is contributed by the hydroelectric source, while 27% of the total electricity production comes from the geothermal source. The largest percentage of renewable energy

[1] Some of the latest studies from the literature regarding the linkage between financial development and energy consumption has been explained with detail in the literature section of the thesis.

(hydroelectric, wind and solar) that contributes to the total production of electricity and the lack of studies that electricity-GDP relationship in Iceland, motivated this study to examine this relationship in the presence of urbanisation and financial development. Sbia et al. (2017) argued in his study that developed infrastructure is a greater source of attraction for urbanisation. It was further argued that the degree of urbanisation can be measured by the inflow of the people to urban areas and the rate of urbanisation. It has been reported by the World urbanisation prospects (the 2014 Revision) that the urban population has risen from 91% in 1990 to 94% in 2014, with an average annual rate of percentage change by 0.2%. This abrupt inflow of the rural population to the urban population has confronted Iceland with many challenges to overcome the demand for energy consumption. Furthermore, the Iceland escalating economic growth has achieved 5th highest GDP per capita among OECD member countries in 2007.

The financial sector[2] of the Iceland has achieved a phenomenal growth in the recent years. Since the 1990s some of the banks were privatised that have achieved meteoric growth over the years. Furthermore, Iceland has commercial banks. The largest banks include Kaupthing Bank, Glitnir and Landsbanki providing the conventional banking services along with the securities trading service. Moreover, the total assets of the largest bank amount €89.6 billion by the end of 2006. The above-mentioned banks of Iceland are privately held. The banks are expanding their operations by investing in foreign that has resulted in generating about 50% of their overall income from abroad.

This suggests that rapid economic growth, urbanisation and improvement in financial development in the recent decades have effected electricity consumption in Iceland through various channels. Ozturk (2010) argued in his study, enhancing the economic growth of any country implies the increase in purchasing power of households that use domestic electrical appliances that cause the upsurge in the demand for electricity consumption. Mishra et al. (2009) argued that the rapid urbanisation is affecting the electricity demand by purchasing the electric appliances, raising demand for new houses, public health care facilities (hospitals and education institutions) public transport and expanding the economic activities. Likewise, the financial development as (Sadorsky, 2010) argued in his study that may affect the electricity demand via,

[2] https://www.cb.is/library/Skraarsafn/Economy-of-Iceland/EOI%20September%202007.pdf

wealth effect, business effect, and consumer effect[3]. This implies that there a need to examine the linkage between financial development, GDP, capital, trade and urbanisation as an additional determinant by using the time series data from 1965-2013. Furthermore, these empirical estimations would be analysed to craft out some comprehensive economic policy for Iceland to achieve sustainable economic development in the long-run.

1.3 Contribution of the study to the existing literature

The present thesis contributes to the existing literature as follows. (1) This thesis augments the electricity demand function by incorporating capital, economic growth, financial development, in addition to the trade and urbanisation. (2) Furthermore, three proxies are used to measure the trade openness. (3) The conventional unit root tests were applied to determine the order of integration in addition to Perron and Vogelsang (1992) that accounts for one endogenous structural break. (4) The ARDL bounds test has been used to investigate the cointegration among the estimated variables. (5) The long-run and short-run elasticities are determined under the framework of ARDL model. (6) The VECM is applied under the framework of ARDL approach along with the variance decomposition to investigate the causality among the estimated variables. (7) The recently developed non-linear ARDL is applied to investigate the non-linear relationship (8) Asymmetric and non-asymmetric causality tests are applied as proposed by Hatemi-J (2012). Furthermore, some policies will be crafted base on the VECM causality.

1.4 Structure of the thesis

This study is composed of mainly six chapters and will be in the following sequence.

Chapter 2; explains the economy of Iceland. The chapter contains information relating the financial sector of Iceland, trade sector, Information regarding Urbanisation in Iceland, and energy sector of Iceland.

Chapter 3; explains the relevant empirical literature from the past studies. The literature section highlights the relevant studies. In the light of those studies, the study gap is ascertained.

[3] The details of these effects have been outline in the literature review section for further explanation.

Chapter 4; shows the econometric methodology by explaining the linear ARDL and non-liner ARDL. Besides this, the VECM causality under the ARDL frame work is applied to investigate the causality. The variance decomposition is also applied to analyse the variations in the variables. Furthermore, the robustness of the linear ARDL will be analysed using the NARDL along with the asymmetric causality using Hatemi-J (2012b). The results have been explained and policies are crafted for Iceland based on the results.

Chapter 5; highlights the empirical estimations based on the methodology of chapter 4. Furthermore, policy implications are also discussed with the empirical estimations for both linear and non-linear models.

Chapter 6; examines the impact of urbanisation and trade on electricity consumption. However, in this chapter, the study is only limited to urbanisation trade, GDP and electricity consumption. The ARDL model is applied to examine the cointegration with VECM to check the causal relationship among the mentioned variables.

Chapter 7; concludes the thesis with some policy implications based on this study.

CHAPTER TWO

2. Economy of Iceland; An overview

2.1. Introduction

The Iceland economy is a small open economy that almost produced GDP of 16.7 billion dollars by the end of the year 2015. This volume of the Iceland economy is 70% large then the economy of Malta. This implies that the small economy of Iceland further suggests that the overall population of Iceland is small which 332.5 (in thousands) by the end of the year 2016 (World Bank). Furthermore, the Gross national income (GNI) amounted more than 46 (k) US dollars by the year 2015 which is measured in terms of purchasing power parities. This makes Iceland 17th highest in the world and 11th among the OECD countries. This further implies that the GNI per capita of Iceland is smaller than that of Norway, Sweden, and Denmark but more than Finland.

2.2. Foreign trade in Iceland

Trade is an important element playing a vital role in the development of an economy. Iceland is having a small open economy with the volume of imports (46%) and exports (53%) by the end of the year 2015 respectively. For the period 2000-2015, the trade openness which is measured as the sum of exports and imports as a percentage of GDP, averaged 86% that is relatively higher as compared to the other OECD countries. Although, a major portion of the trade in Iceland still depends on the large share of primary products. Yet the exports have increased manifold and grown rapidly for the last 10-15 years. However, the geographic distance that is far away from the populated cities, transit trade, and limited intra-industry are some of the barriers that restrict trade openness. Marine products and fish contribute to exports by 42% by the year 2015. While some of the locally manufactured goods that include medical and pharmaceutical products that account for 53% of goods exported by the year 2015 that makes 28% of the total export.

In the recent decades, the service sector in Iceland has performed well. The economy of Iceland has expanded with a significant improvement in the service sector. Thus, resulting in service oriented country. The tourism sector in Iceland has been an important element that promotes the export growth by contributing 47% to the total export revenue by the year 2015.

The Iceland import includes a wide variety of commodities and manufactured goods including capital goods, industrial supplies, and consumer goods. Capital goods contribute 21%, while consumer goods contribute to the total goods by 27% to the total imports respectively. In addition, the service sector also contributes to 36% of the total imports. In the recent years, the volume of trade has upsurge. The trade volume was 43% by the year 2015, which is one of the highest volumes of trade among the OECD countries. Most of the trading in Iceland is done in euros that count for 25% of the total exports. Besides this US dollar contributes to the Iceland export by 18%, while Danish krone and pound sterling contributes to 11% for a total volume of trade.

The upsurge in the trade as explained in the previous section is because of free trade agreement of Iceland with Europe thus causing the share of North America to decrease. It has been known, that 78% of the exports and 61% of imports of Iceland has done with a member of the European economic area. The largest trading partner of Iceland currently includes Germany, the US, Norway and Spain. In the recent year, trade of Iceland with China has significantly increased that makes the China 9th largest Iceland trading partner. The Iceland has favourable terms of trade with Nigeria, Russia, the UK, the Netherlands, France and Japan.

2.3. Electricity sector

Iceland is focussing more on the use of renewable energy resources. The major portion of prime energy supply (almost 90%) is obtained from renewable resources. Iceland has been gifted with a potential source of huge reservoirs of renewable energy. Iceland is located geographically in a region which is more volcanically active and is considered to be one of a strong source of geothermal energy. While on another hand major portion of the Iceland is covered by the glaciers which are a major source of water that can be used to generate electricity based on water power. Both the hydropower and geo thermal sources are the important source from which Iceland is generating electricity and providing it to the end users with the cheapest price among the OECD. Because of the two reservoirs, Iceland is producing highest electricity per capita in the world with a magnitude of 55 megawatt hours (MWh) per capita more than double, that in Norway which comes second after Iceland. In the year 2015, the electricity generated using hydropower reached to 1,986 megawatts (MW) with an aggregate capacity of 13,800 gigawatt hours (GWh). While the electricity generation from 7 plants using geo-power reaches to 665 MW with an aggregate capacity of 5000

GWh. This shows that geothermal and hydropower are the important reservoirs to generate electricity. The price of electricity in Iceland is very cheap that counts half of the price to consumers as compared to the rest of the Europe.

2.4. Financial Sector in Iceland

The financial sector of Iceland has strengthened a lot in the first decade of the 21st century. The deregulation in the 1990's, financial globalization, and the privatization of some commercial banks have stimulated financial development that performed much better in the recent years. The assets of the banking system rose significantly almost 10 times GDP by the year 2007. After early 2009, the banking system in Iceland changed significantly. Additionally, three new banks started operation and more importantly after the restructuring of the previous commercial banks, and small financial institutions, that causes the financial system of the Iceland to be more strengthened. Currently, four savings banks and four commercial banks are working in Iceland. The state is the major owner of the commercial banks and holds the majority of shares in those banks. Besides this, some of the credit institutions are also operating in the Iceland, which includes two investment credit funds, credit card companies and House Financing Fund (HFF).

2.5. Urbanisation in Iceland

Urbanisation is the inward migration of the people from rural areas to the urban areas. This movement of the people from the rural areas to urban areas depends on the facilities that include health, infrastructure, telecommunications etc. The role of urbanisation in the recent decades have been significant. Various studies in the past and the recent literature have shown that although there are many benefits of urbanisation, at the same time the overcrowding in the urban cities make it difficult for the governments to provide the facilities that can cater their needs. Urbanisation in Iceland has been on the rise like other countries. The urban population is 94.1% of the total population in Iceland by the end of 2015with an annual rate of 1.25%. This rate of urbanisation has made Iceland one of the highest in urbanisation among the OECD countries.

CHAPTER THREE

3. Literature Review

3.1 Financial development (FD) and Electricity consumption (EC)

There is a huge literature on economic growth and financial development not only for the developed countries but also for the developing countries as well. Many studies have clarified the connection between FD and GDP. However, the impact of FD on electricity consumption has been documented by few studies. For example, Dan and Lijun (2009) and Karanfil (2009) conducted a study in China using the bivariate model including Financial development and energy consumption. Their studies findings suggested that energy consumption in China Granger cause financial development. Sadorsky (2010) utilised multiple proxies of financial development in 22 emerging economies. It was concluded with a positive impact of FD on EC. However, the magnitude of this impact was small. Sadorsky (2011) conducted a study for Central and East European frontier economies by applying the dynamic panel data model. A positive relation between EC and FD was revealed. Xu (2012) re-conducted a study and extended further the study for China by including 29 Chinese provinces to analyses the relationship between financial development and energy consumption. The results of the study suggested that the measure of financial development was actually a cause of the existence of the long-run relationship. Shahbaz and Lean (2012) examined the energy demand function by analysing the effect of FD on energy use. The results of their study showed that FD effects stock market development positively. They further argued that FD increases demand for energy that significantly effects stock market development thus accelerating the economic activities. This further implies that both FD and EC are causing each other. Shahbaz et al. (2013) conducted a study including financial development and energy consumption in the production function for China. The ARDL bounds testing approach was used to investigate the relationship in their study. Also, Granger causality was applied to investigate the causal effect both short-run and long-run among the estimated variables under the framework of VECM. The results of their study identified that FD effect positively EC. They further noticed that financial development also Granger cause energy consumption. Ozturk and Acaravci (2013) conducted a study for Turkey and investigated the causal relationship between financial development, economic growth, energy consumption-carbon dioxide emission and trade for period 1960-2007. The findings of their study suggested a long-run relationship among the estimate variables using the bounds test of cointegration. The results further showed a positive rise in foreign trade to GDP ratio significantly and positively affects per capita carbon emissions, while the financial development has no significant role on carbon emission in the long-run. Their findings also proved the validity of EKC hypothesis in their study for Turkey.

Sbia et al. (2014) conducted a study for UAE which examined the relationship between that includes trade openness, clean energy, FDI, economic growth and carbon emissions by applying quarterly data that covered the period from 1975Q1-2011Q4. The structural break unit root tests were applied to examine the stationarity properties of the variables. The cointegration among the selected variables in the study was examined under the ARDL bounds testing approach accommodating the break dates that has been obtained from the structural break unit root test. The results suggested an evidence of a long-run relationship among the estimated variables. Furthermore, carbon emission, trade openness and FDI decreases energy demand, while the clean energy and economic growth have a positive impact on the energy demand. Later on Salahauddin et al. (2015) further expanded the study by including financial development and electricity consumption along with the carbon emission and economic growth covering a period from 1980-2012 using panel data that includes the Gulf Cooperation Council (GCC). The results of their study suggested that both the economic growth and electricity have a positive and significant impact on Co_2 emission while financial development has a negative and significant impact on Co_2 emission. The results of their studies further suggested that economic growth and electricity consumption are responsible for the upsurge of Co_2 emission, while the financial development lessens the Co_2 emission. The evidence of the Granger causality indicates an evidence of bidirectional causal relationship among the Co_2 emission and economic growth, while a uni-directional causality was found from electricity consumption to pollution. Kumar et al. (2016) conducted a study for UAE to analyse the possible linkage between financial development and energy consumption by using time series data from 197-2011. The findings of their study indicated a strong evidence of long-run cointegration and the robustness of those findings was proved in their study by using the Bayer-Hanck (2013) combine cointegration. The long-run results of their findings suggested that FD positively effects positive EC. The results of their study further indicated that economic growth has a negative impact on energy consumption, while urbanisation and capital are identified as a strong determinant of the energy consumption. An existence of inverted U-shaped relationship was reported in their study. Khraief et al. (2016) determined an electricity demand function using urbanisation and trade in their econometric model. The ARDL bounds test of cointegration was applied to determine the long-run relationship among the estimated variables. The robustness of the ARDL bounds testing approach was confirmed using the Bayer-Hanck (2013) combine cointegration. The long-run results revealed a positive impact of economic growth and urbanisation on electricity demand function. However, a negative and statistically significant relationship was found with the trade. A recent study conducted by Ahmad (2017) to investigate the energy-growth nexus using the key financial indicator in newly industrialised nations consisting of BRICS countries. The study found the evidence of cointegration by using Johansen Fisher Panel Cointegration Test. The robustness of the Johansen Fisher Panel Cointegration Test was analysed by using Bayer and Hanck Panel Cointegration Analysis. Furthermore, the overall findings of the study indicated that trade, financial development and economic growth upsurge energy intensity for BRICS countries. The evidence of environmental Kuznets curve (EKC) was also found among energy consumption and trade and with energy consumption and financial development. While the capital is found to contribute to the energy efficiency after reaching a threshold level.

3.1. Electricity Consumption and Economic Growth

Sbia et al. (2017) argued in their study that electricity has so far played a major role in improving living standards of human by improving the infrastructure (telecommunication, transportation). The electricity consumption is considered to one of the major determinants of the growth of not only of the developed but also for the developing countries. Electricity usage has become commercial in all sectors of the economy. Therefore, its role in determining the optimal economic growth cannot be ignored. This has attracted the attention of the major researchers that needs to be further investigated to get its utmost benefit. The pioneering study of Kraft and Kraft (1978) thus is considered as a base for further studies. Later on, Rosenberg (1998) investigated the role of electricity in the industrial development. However, because of its extensive research for electricity consumption and economic growth nexus, Ozturk

(2010) has identified four different hypotheses in his study. 1) Growth hypothesis which suggests that electricity consumption induces growth in the economy. 2) The feedback hypothesis which implies that both the electricity consumption and economic growth are causing each other. 3) The growth-led hypothesis which suggests that economic growth is causing electricity consumption also known as conservation hypothesis. 4) Neutrality hypothesis that suggests that neither economic nor electricity consumption can cause each other.

These hypotheses have been confirmed for many studies that have been conducted over a period of time. For instance, in the recent studies which include Odhiambo (2009a) conducted for Tanzania, Gupta and Chandra (2009) analyse it for India, Adebola (2011) reported it for Botswana, and Acaravci and Ozturk (2012) investigated for Turkey, that all validated the growth hypothesis in their studies. Whilst, some of the studies confirmed conservation hypothesis that includes the study of Narayan and Smyth (2005) for Australia, Mozumder and Marathe (2007) for Bangladesh. Hu and Lin (2008), Shahbaz and Feridun (2012) for Pakistan. Their studies recommended that it is because of the economic growth that is causing electricity consumption. Likewise, neutrality hypothesis has been validated in the studies of Acaravci and Ozturk (2010) for transition countries, Akpan and Akpan (2012) for Nigeria, Fateh and Abderrahmani (2013) for Algeria. Similarly, some of the studies also reported the existence of feedback hypothesis that includes Dogan (2015) for Turkey, Lin and Liu (2016) for China, Rafindadi and Ozturk (2016) for Japan and Cerdeira and Moutinho (2016) for Italy. This implies that both economic growth and electricity consumption Granger cause each other. This further identifies that both the economic growth and electricity consumption are interdependent on each other. In this regards the energy exploration policies should be encouraged to have sustainable economic growth in the long-run.

3.2. Urbanisation and Electricity consumption

Jones (1991) in his study argued that urbanisation is identified as one of the major factors that promote economic development. The population of the urban area increases as more people migrate to the urban areas in search of the better facilities that upsurges the demand for basic inputs like the infrastructure including transportation, provision of services, education and health. In a recent study of Duan et al. (2008) conducted for China to investigate the effect of urbanisation and energy consumption. Their study findings confirm the existence of a long-run relationship among the energy consumption, population and urbanisation. Furthermore, a uni-directional causality was found from urbanisation to energy consumption while a neutral effect was found in population and energy consumption. In another study for China conducted by Xie et al. (2009) using electricity consumption together with urbanisation. The results of their study highlighted a long-run equilibrium relationship between electricity consumption and urbanisation in China. The results of causality test indicated an evidence of feedback long-run causality between urbanisation and electricity consumption. However, no effect was found among both the variables that validate the neutral hypothesis in the short-run. Abouie-Mehrizi et al. (2012) conducted a study to analyse the relationship between urbanisation, energy consumption, and pollution. The findings of their study highlighted that both the urbanisation and population growth necessitates for more energy in the long-run.

Zhang and Lin (2012) in his study identified that the increasing population of urban upsurges the demand for energy and Co_2 emissions. They utilised STIRPAT model to investigate the impact of urbanisation on Co_2 emissions and energy consumption. Their findings showed that urbanisation causes an increase in the Co_2 emissions and energy consumption.

Similarly, in another study for China conducted by Liddle and Lung (2013) utilising panel data for 105 countries for a period 1971-2009. Their findings suggested an evidence of long-run uni-directional causality that moves from electricity consumption to urbanisation. The energy demand function was investigated by Islam et al. (2013) for Malaysia to analyse the impact of population and economic growth in energy demand. The evidence of long-run relationship was found using ARDL bounds testing of cointegration. Later, on VECM Granger causality was applied. The findings highlighted a positive impact of population and economic growth in energy consumption. Furthermore, bidirectional causality was found in population and energy demand.

In a recent study of Shahbaz et al. (2014) investigates the relationship between urbanisation. Economic growth, pollution and electricity consumption applying the time period 1971-2011 for UAE using quarterly frequency. The findings revealed the existence of a long-run relationship in the presence of structural breaks. Furthermore, an evidence of EKC was confirmed. A negative relationship with the exports showed that evidence of improving the environmental quality. The causality results indicated a feedback effect between electricity usage and Co_2 emissions. Al-Mulali and Ozturk (2015) conducted a study for MENA region using trade openness, industrial development, urbanisation, and energy consumption. The results of their study suggested that trade openness, industrial production and energy consumption damages the environment by propagating pollution. However, the political stability has a negative effect on the pollution. In one of the recent studies by Khraief et al. (2016) investigated the electricity demand function using urbanisation, economic growth and trade for Algeria using a time period from 1972-2012. They found the evidence of cointegration under the framework of an ARDL model in the presence of structural breaks. The study findings concluded that urbanisation, economic growth has a positive impact on electricity consumption while trade has a negative effect on electricity consumption. An evidence of feedback relationship was found between urbanisation and electricity consumption. Ozatac et al. (2017) conducted a study for Turkey to analyse the environmental Kuznets curve (EKC) hypothesis for period 1960-2013 using Trade, urbanisation, energy consumption, financial development. The findings of their study confirmed the existence of EKC for Turkey. Furthermore, an insignificant impact of financial development was found. However, urbanisation, trade, and energy consumption positively and significantly affect pollution. The causality results of their study found the evidence of uni-directional causality from trade openness to pollution that confirmed the scale effect for Turkey.

CHAPTER FOUR

4. Theoretical Frame work and Econometric Methodology

4.1 Theoretical Framework

The theoretical framework in this section is outlined followed by the econometric methodology. Many studies in the literature have documented the relationship between economic growth and financial development as explained in the literature section. The recent studies on the relationship between financial development and economic growth include Shahbaz (2012); Faisal et al. (2017) along with some other studies that contribute significantly to the literature. However, the literature on the investigation of the causal relationship between financial development and energy consumption is insufficient. However, the importance of financial development and its significance in explaining the energy demand using various channels cannot be ignored. Mahalik et al. (2016) argued in their study that financial development improves the economies of the developed and developing countries by allowing the inward foreign direct investment (FDI) that stimulates banking activities, stock market development and other financial intermediaries like insurance companies etc. In this connection, Mishkin (2009) highlighted the role of financial development in their study theoretically by arguing that financial development is very important for a country. The economic efficiency of any country and the quality of institutions can only be improved and enhanced by improving the financial sector. This improvement in the financial sector stimulates technological progress, decrease in the transaction costs and also brings quality reforms in the institutions. Thus, because of the financial liberalisation, the financial development in countries are efficient enough to mobilise savings and enhance economic growth. Furthermore, it has been clarified that upsurge in GDP is causing the increasing consumption of energy, thus increasing the demand for the energy consumption, especially in the urban areas. This suggests that EC effects GDP positively. Furthermore, financial development in in the emerging market economies also affects demands for energy (Sadorsky, 2010, 2011). However, Kumar et al. (2016) in their study highlighted business effect, wealth effect & consumer effect as possible effects of FD for energy demand. Sadorsky (2010); (2011) elucidated in their studies that with better financial development the drive for energy by the consumers' upsurges. This suggests that easy access to the loan and other facilities provided by the bank enables the consumer to acquired big ticket items as washing machines, cars, refrigerators. This would help the consumer to satisfy their needs. Thus, by acquiring these big items can cause in an increased energy demands thus raising the aggregate demand in a country for energy. Similarly, the demand for energy by the business firms also upsurges because of the improved financial development. A well develops financial system may provide better facilities to the business firms by mobilising their savings into productive channels thorough affordable interest rates thereby increasing their day-to-day investment. Although, the business firms get benefits from the improved financial development by expanding their businesses and/or opening new ventures that require more labour, machinery and the use of plants and equipment's thus causing an increase in energy demand. Finally, the wealth effect as a result of the improved financial system also induces to consume more energy, thus raising the energy demand. Tursoy and Faisal (2016) confirmed in their study, that stock market activity can be used to predict economic growth and prosperity about an economy. Moreover, it also helps to create a wealth effect by building the trust and confidence of the business firms and consumer. Sadorsky (2010); (2011) and Chang (2015) argued in their study, that both business and consumers' firms can get the advantage by investing in equity using the stock market. The confidence level of the consumer and business firms rises due to the good will of the stock market that encourages the firms to invest more in stocks as an additional source of equity financing. This causes upsurges in the economic equity thus raising the country demand for the energy.

The above discussion assists us to construct a concrete theoretical background on the interrelationship of energy demand by the consumers and the financial development. However, the literature on the linkage between financial developments with electricity demand appears to be scanty especially for the OECD economies. In the light of the above discussion, the research question needs to be answered. Whether financial development can cause an upsurge in the electricity demand in Iceland using trade, urbanisation, economic growth and capital as the determinant of the electricity demand function? Since to the extent of our knowledge, no study has investigated the relationship between electricity consumption and financial development by using capital together with trade and electricity urbanisation as an additional determinant of electricity consumption. This study uses annual data covering a time period from 1965-2013. The times series data set sample was chosen based on the availability of the data. The World Bank development (2017) are explored to gather data on electric power consumption (kWh per capita), gross fixed capital formation as a percentage of GDP is used as a proxy to measure capital, urban population, real GDP per capita (constant 2010 US$), trade as a percentage of GDP. However, it was not easy to choose one proxy that measures appropriately the financial development. Existing literature contains numerous studies that utilise different financial proxies to measure the impact of financial development. Khan and Qayyum (2007) argued in their study by using all the proxies of financial development separately may cause multi-colinearity or a spurious relationship, and the results obtained from those estimations may not be reliable. This motivates us to generate appropriate financial development index to avoid biasnes of our empirical results. This study utilizes principal component method (PCM) to generate an appropriate index of financial deepening for the case of Iceland.

To the best of knowledge, some of the studies have utilised financial development index using different indicators. For instance, Ang and Mckibbin (2007) utilised liquid liabilities, domestic credit to the private sector, and commercial bank assets to the commercial banks as a percentage of GDP for Malaysia. Khan and Qayyum (2007) conducted a study for Pakistan to generate financial deepening index using domestic credit to the private sector as a percentage of GDP, total bank deposit liabilities as a share of GDP, stock market capitalization as a share of GDP and clearing house amount as a share of GDP. Later on, Jalil and Feridun (2011) generated financial deepening index by utilising the same proxies excluding stock market capitalization. Hye (2011) conducted a study for India by generating a financial development index using financial innovations to analyse the impact of research and development activities in the financial sector.

Pradhan et al. (2017) conducted a study for ARF countries using banking sector development variables. The banking sector development indicators in their study include domestic credit to the private sector, domestic credit provided by the banking sector, broad money supply and domestic credit provided by the financial sector. All these indicators have been used as a percentage of GDP. Following Pradhan et al. (2017), this study also utilised banking sector development variables as a percentage of GDP to construct the index of financial deepening. We use Principal component model (PCM) explain the relative importance of each series. Table 4.2 shows the result of PCA for financial deepening.

Table 4.1.Construction of financial development indicator based on the banking sector development variables

BMS	A broad money supply which is expressed as a percentage of the gross domestic product.
DCB	Domestic credit provided by the banking sector to economy and expressed as percentage of GDP
DCF	Domestic credit provided to the economy by the financial sector and expressed as percentage of GDP
DCP	Domestic credit to the private sector and expressed as percentage of GDP
FD	Represents the composite index of the banking sector development which is constructed using the BMS, DCB, DCF, DCP.

Table 4.2.Principal Component Analysis for financial development using Banking sector

Eigen values of the observed matrix						
Eigen values: (Sum=4, Average=1)						
Number	Value	Difference	Proportion	Cumulative value	Cumulative proportion	
1	3.7510	3.5186	0.9378	3.7510	0.9378	
2	0.2324	0.2159	0.0581	3.9834	0.9959	
3	0.0164	0.0164	0.0041	3.9999	1.0000	
4	6.37E-05	-------	0.0000	4.0000	1.0000	
Eigen Vectors (loadings)						
Financial development proxies			PC1	PC2	PC3	PC4
BMP_t			0.4682	0.8736	0.1320	0.0114
$DCFP_t$			0.5090	-0.3351	0.3508	0.7109
$DCPP_t$			0.5094	-0.3210	0.3785	-0.7028
$DCFPP_t$			0.5119	-0.1462	-0.8462	-0.0178

Note: where BMP, DCFP, DCPP, and DCFPP represents broad money supply, domestic credit provided by the banking sector, domestic credit provided by the financial sector and domestic credit provided to the private sector as % age of GDP.

In Table 4.2 the first factor has a maximum Eigen value is 3.7510 followed by the second factor 0.2324. The lowest factor value is 6.37E-05. The table further shows that 93.78% of the standard variance is explained by the first principal component, 5.81% by the second principal component and followed by 0.41% by the third principal component. It can be further noted that the first principal component is better than the other three components as a high level of variance is explained by the 1st component.

Also, the Eigen vector loadings (PC1, PC2 and PC3) suggests that majority of the values of PC2 and PC3 are negative and lowest in most of the cases. Therefore, based on these reasons this study utilises the values of first Eigen vector (PC1) factor loadings to construct the index for financial deepening and is represented by *FD*. The financial indicators based on the banking sector development and along with their definitions and measurements have been presented in Table 4.1. Based on the above specification and discussion the functional specification of the model by following Mahalik et al. (2016) and expanding the model as identified by Khraief et al. (2016) by using trade

Table 4.3.Definition variables along with their measurements used in the study

Variable	Measurement
ln EK_t	The natural logarithm of electric power consumption measured in kilowatt hour per capita (KWh).
ln GDP_t	The natural logarithm of real GDP per capita that is measured in constant 2010 US$.
ln FD_t	The natural logarithm of financial Deeping index that is constructed using the banking sector development variables.
ln FD_t^2	The square of the natural logarithm of financial Deeping index.
ln K_t	The natural logarithm of gross capital formation measure as %age of GDP and is used a proxy to measure the capital.
ln URB_t	The natural logarithm of urban population living in the urban areas
ln TR_t	The natural logarithm of trade as %age of GDP.
ln EXP_t	The natural logarithm of exports as % age of GDP.
ln IMP_t	The natural logarithm of imports as % age of GDP.

along with urbanisation, capital, and GDP as an additional determinant of the electricity demand function for Iceland. The functional specification of the model can be written as

$$EK_t = f(\mathrm{GDP_t}, \mathrm{FD_t}, \mathrm{K_t}, \mathrm{URB_t}, \mathrm{TR_T}) \quad (4.1)$$

$$\ln EK_t = \beta_1 + \beta_2 \ln GDP_t + \beta_3 \ln FD_t + \beta_4 \ln K_t + \beta_5 \ln URB_t + \beta_6 \ln TR_t + \mu_t \quad (4.2)$$

$$\ln EK_t = \alpha_1 + \alpha_2 \ln GDP_t + \alpha_3 \ln FD_t + \alpha_4 \ln FD_t^2 + \alpha_5 \ln K_t + \alpha_6 \ln URB_\mathrm{t} + \alpha_7 \ln TR_t + \mu_t \quad (4.3)$$

All the variables in equation 4.3 were converted into the log-log specification[4]. ln EK_t Electric power consumption (kWh per capita), ln GDP_t represents the natural log of real GDP per capita (constant 2010 US$), ln FD_t represents the natural log of financial development index, ln K_t represents real capital use for which gross fixed capital formation as percentage of GDP is used as proxy, ln URB_t represents the urban population, ln TR_t represents the natural log of trade as percentage of GDP and μ_t represents the error term that must be white noise. The total population data collected from the World Bank development indicators (CD-ROM, 2017) is used to convert the series into per capita units. The expected sign for β_2 is positive as electricity consumption is positively affected by the economic growth, therefore the expected coefficient of $\beta_2 < 0$ (Shahbaz and Lean, 2012). The expected sign of β_3 is negative, provided that FD has a negative effect on electricity usage (Tamazian et al. 2009). Financial development causes an upsurge in the electricity demand if the projects are not evaluated and monitored by the financial sector after allotting the funds (Zhang, 2011) then it is expected that $\beta_3 > 0$. A positive relationship is expected between capital and electricity consumption. If the capital use is energy intensive then in such case it is expected that $\beta_4 > 0$, otherwise $\beta_4 < 0$. Urbanisation brings more structural changes throughout the economy and has an important effect on electricity consumption. The rise is urbanisation is causing an upsurge in the electricity demand, therefore it is expected that $\beta_5 > 0$ otherwise $\beta_5 < 0$. Trade causes an increase in electricity demand so it is expected that $\beta_6 > 0$, otherwise $\beta_6 < 0$. A squared term of the financial development was inserted in order to capture the non-linear relationship between electricity consumption and economic growth. Shahbaz et al.(2013a, 2013b) in their studies that initially the energy demand upsurges as there is an improvement in the financial development, but after reaching to threshold level of financial development, financial sector is more efficient and evaluates the resource allocation of the firms by encouraging the firms to adopt energy efficient technology that declines energy intensity. Thus, the relationship between financial development and electricity consumption must be an inverted U-shaped if $\alpha_3 > 0$, and $\alpha_4 < 0$, otherwise there would be a U-shaped relationship. Lin and Liu (2016) identified the rise in urban population, Industrialisation and household sector as the main cause for electricity demand. This abrupt rise in urbanisation and trade openness has attracted the attention to developing

[4] The data transformation to natural logarithm give smoothness to the data. Furthermore, it also helps to eliminate the potential heteroscedasticty in the data, if there is any (Tursoy and Faisal, 2016).

ICT, financial activities, improvement of urban cities infrastructure, and promoting trade. In developed countries, public transportation and mass transit services are based on electronically functional. Based on such infrastructure that encourages not only the domestic economic activities but also upsurges the imports and exports. Therefore, this study used three proxies to measure the trade openness. Imports, real exports, and real trade. All these proxies of trade openness are converted to per capita using total population data.

4.2 Econometric Methodology

The study employed the Augmented Dickey-Fuller (ADF) unit root test as proposed by Dickey and Fuller (1979) to determine the integration order of series. Furthermore, Phillips-Peron (PP) unit root tests as proposed by Phillips and Perron (1988) in addition to the KPSS unit root tests as suggested by Kwiatkowski et al. (1992) to increase the robustness of the selected variables. However, as Perron (1989) argued in his study that the conventional unit root test may incorrectly determine the order of integration that does not take into the account of the structural breaks that is steaming into the series. Ender (2004) argued that Perron and Vogelsang (1992) are more appropriate when the break dates in the series are unknown and uncertain. Shrestha and Chowdhury (2005) further suggested that Perron and Vogelsang (1992) is more powerful and superior as compared to Zivot-Andrews (1992) unit root test when it comes to analysing the structural breaks into the series. Given this motivation, this thesis utilised the Perron and Vogelsang (1992) unit root test in addition to the conventional unit root test that takes into the account of one structural break in a series identifying the integration order. Furthermore, the two forms of the test are additive outlier model (AO) and the innovative outlier model (IO). The additive outlier model captures the sudden changes in the series if any exists. While the innovative outlier model (IO) that captures the gradual shift in the series along with the break dates.

This study further applies the Autoregressive distributed lag (ARDL) bounds test as proposed by Pesaran et al. (2001) to examine the long-run relationship between the estimated variables. The ARDL bounds technique is preferred over other approaches as it doesn't require any unique order of integration among the series. The ARDL model can apply to any series having a mixed order of integration. However, it must be ensured that the dependent variable must be I (1). The bounds test is superior to Johansen in a sense that it performs more efficiently in a small sample. The optimal lags in the ARDL model have selected individually for both regressors and regressand, eliminating the problem of endogeneity as it arises in other models. The error correction mechanism can be used to integrate the short-run adjustment with the long-run via simple linear transformation. The list of regressor and regressand can be distinguished in ARDL model. However, the computed F-statistics values based on the Pesaran et al. (2001) cannot be applied to the variable which is integrated of order 2 or I (2). The bounds test of cointegration will be applied to examine the evidence of a long-run relationship among the estimated variables in the model. The equations for the bounds test can be written as

$$\begin{aligned}\Delta\ln EK = {} & \beta_0 + \sum_{i=1}^{p} \beta_i \Delta\ln EK_{t-i} + \sum_{j=0}^{q} \beta_j \Delta\ln GDP_{t-j} \\ & + \sum_{l=0}^{r} \beta_l \Delta\ln FD_{t-l} + \sum_{m=0}^{s} \beta_m \Delta\ln K_{t-m} + \sum_{n=0}^{t} \beta_n \Delta\ln URB_{t-n} \\ & + \sum_{w=0}^{u} \beta_w \Delta\ln TR_{t-w} + \beta_{EK}\ln EK_{t-1} + \beta_{GDP}\ln GDP_{t-1} + \beta_{FD}\ln FD_{t-1} \\ & + \beta_k \ln K_{t-1} + \beta_{URB}\ln URB_{t-1} + \beta_{TRA}\ln TRA_{t-1} \\ & + \upsilon_t, \qquad (4.4)\end{aligned}$$

$$\begin{aligned}& \Delta\ln GDP \\ & = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta\ln GDP_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta\ln EK_{t-j} \\ & + \sum_{l=0}^{r} \alpha_l \Delta\ln FD_{t-l} + \sum_{m=0}^{s} \alpha_m \Delta\ln K_{t-m} + \sum_{n=0}^{t} \alpha_n \Delta\ln URB_{t-n} + \sum_{w=0}^{u} \alpha_w \Delta\ln TR_{t-w} \\ & + \alpha_{EK}\ln EK_{t-1} + \alpha_{GDP}\ln GDP_{t-1} + \alpha_{FD}\ln FD_{t-1} + \alpha_k \ln K_{t-1} + \alpha_{URB}\ln URB_{t-1} \\ & + \alpha_{TRA}\ln TRA_{t-1} \\ & + \upsilon_t, \qquad (4.5)\end{aligned}$$

$$\Delta \ln FD = \vartheta_0 + \sum_{i=1}^{p} \vartheta_i \, \Delta \ln FD_{t-i} + \sum_{j=0}^{q} \vartheta_j \, \Delta \ln EK_{t-j} + \sum_{l=0}^{r} \vartheta_l \, \Delta \ln GDP_{t-l} + \sum_{m=0}^{s} \vartheta_m \, \Delta \ln K_{t-m} + \sum_{n=0}^{t} \vartheta_n \, \Delta \ln URB_{t-n} + \sum_{w=0}^{u} \vartheta_w \, \Delta \ln TR_{t-w} + \vartheta_{EK} \ln EK_{t-1} + \vartheta_{GDP} \ln GDP_{t-1} + \vartheta_{FD} \ln FD_{t-1} + \vartheta_k \ln K_{t-1} + \vartheta_{URB} \ln URB_{t-1} + \vartheta_{TRA} \ln TRA_{t-1} + \upsilon_t \quad (4.6)$$

$$\Delta \ln K = \rho_0 + \sum_{i=1}^{p} \rho_i \, \Delta \ln K_{t-i} + \sum_{j=0}^{q} \rho_j \, \Delta \ln EK_{t-j} + \sum_{l=0}^{r} \rho_l \, \Delta \ln GDP_{t-l} + \sum_{m=0}^{s} \rho_m \, \Delta \ln FD_{t-m} + \sum_{n=0}^{t} \rho_n \, \Delta \ln URB_{t-n} + \sum_{w=0}^{u} \rho_w \, \Delta \ln TR_{t-w} + \lambda_{EK} \ln EK_{t-1} + \rho_{GDP} \ln GDP_{t-1} + \rho_{FD} \ln FD_{t-1} + \rho_k \ln K_{t-1} + \rho_{URB} \ln URB_{t-1} + \rho_{TRA} \ln TRA_{t-1} + \upsilon_t \quad (4.7)$$

$$\Delta \ln URB = \varphi_0 + \sum_{i=1}^{p} \varphi_i \, \Delta \ln URB_{t-i} + \sum_{j=0}^{q} \varphi_j \, \Delta \ln EK_{t-j} + \sum_{l=0}^{r} \varphi_l \, \Delta \ln GDP_{t-l} + \sum_{m=0}^{s} \varphi_m \, \Delta \ln FD_{t-m} + \sum_{n=0}^{t} \varphi_n \, \Delta \ln K_{t-n} + \sum_{w=0}^{u} \varphi_w \, \Delta \ln TR_{t-w} + \varphi_{EK} \ln EK_{t-1} + \varphi_{GDP} \ln GDP_{t-1} + \varphi_{FD} \ln FD_{t-1} + \varphi_k \ln K_{t-1} + \varphi_{URB} \ln URB_{t-1} + \varphi_{TRA} \ln TRA_{t-1} + \upsilon_t \quad (4.8)$$

$$\Delta \ln TRA = \sigma_0 + \sum_{i=1}^{p} \sigma_i \, \Delta \ln URB_{t-i} + \sum_{j=0}^{q} \sigma_j \, \Delta \ln EK_{t-j} + \sum_{l=0}^{r} \sigma_l \, \Delta \ln GDP_{t-l} + \sum_{m=0}^{s} \sigma_m \, \Delta \ln FD_{t-m} + \sum_{n=0}^{t} \sigma_n \, \Delta \ln K_{t-n} + \sum_{w=0}^{u} \sigma_w \, \Delta \ln URB_{t-w} + \lambda_{EK} \ln EK_{t-1} + \lambda_{GDP} \ln GDP_{t-1} + \lambda_{FD} \ln FD_{t-1} + \lambda_k \ln K_{t-1} + \lambda_{URB} \ln URB_{t-1} + \lambda_{TRA} \ln TRA_{t-1} + \upsilon_t \quad (4.9)$$

Where Δ represents the first difference and υ_t represents the error term that must be white noise. The AIC criterion is used to select the optimal lag. The summation signs in the above equations represent the short-run while λ on the other side of the equation represents the long-run. The Joint F-statistics or Wald test is employed to examine the presence of the long-run relationship by testing the null hypothesis of no cointegration for instance in Equation is $H_{0:}$ $\beta_{EK}=\beta_{GDP}=\beta_{FD}=\beta_{K}=\beta_{URB}=\beta_{TR}=0$ against the alternative hypothesis of no cointegration H_1: $\beta_{EK}=\beta_{GDP}\neq\beta_{FD}\neq\beta_{K}\neq\beta_{URB}\neq\beta_{TR}\neq 0$. The two asymptotic critical bounds values are utilized to examine the presence of cointegration. If the regressors are *I* (0), the lower bound is applied and *I* (1) is utilized for the upper bounds, if the regressors are *I* (1). The F-statistics computed is compared with the upper bounds *I* (1) and lower bounds *I* (0) critical values. If the estimated F-Statistics lies above the upper bounds critical values. Thus we reject the null hypothesis of cointegration. This further implies the evidence of cointegration among the estimated variables. If the estimated lies in between the upper and lower bounds critical values, then the decision regarding the cointegration is inconclusive. If the computed F-statistics lies below the lower bounds critical values. Then, the null hypothesis of no cointegration cannot be rejected. Furthermore, there is no evidence of cointegration. It is important to mention here, that if the order of the integration of series is known *I*(1), then the decision regarding cointegrtion is based on *I*(1). If the order of integration is *I*(0) then the decision is based on lower bounds critical values. Once the cointegration is identified among the regressors, the long-run and short-run elaticities are estimated using the following equations.

$$\ln EK = \alpha_1 + \sum_{i=1}^{p} \sigma 1_{\mathrm{i}} \ln EK_{\mathrm{t-i}} + \sum_{k=1}^{q} \omega 1_{k} \ln \mathrm{GDP}_{\mathrm{t-k}} + \sum_{l=1}^{r} \partial 1_{l} \ln \mathrm{FD}_{\mathrm{t}-l} + \sum_{m=1}^{s} \emptyset 1_{m} \ln \mathrm{K}_{\mathrm{t-m}} + \sum_{l=1}^{t} \gamma 1_{l} \ln \mathrm{URB}_{\mathrm{t}-l} + \sum_{l=1}^{u} \rho 1_{l} \ln \mathrm{TR}_{\mathrm{t}-l} + \mu_{\mathrm{t}} \tag{4.10}$$

$$\ln EKt = \gamma_0 + \sum_{i=1}^{p} \gamma 1_{\mathrm{i}} \, \Delta \ln EK_{\mathrm{t-i}} + \sum_{k=1}^{q} \gamma 1_{k} \Delta \ln \mathrm{GDP_{t-k}} + \sum_{l=1}^{r} \gamma 1_{l} \, \Delta \ln \mathrm{FD_{t-\mathit{l}}}$$

$$+ \sum_{m=1}^{s} \gamma 1_{m} \, \Delta \ln \mathrm{K_{t-m}} + \sum_{l=1}^{t} \gamma 1_{l} \, \Delta \ln \mathrm{URB_{t-\mathit{l}}} + \sum_{l=1}^{u} \gamma 1_{l} \Delta \ln \mathrm{TR_{t-\mathit{l}}}$$

$$+ \psi \mathrm{ECT_{t-1}} + \mu_{\mathrm{t}}$$

(4.11)

Where "ECT_{t-1}" represents the error correction term. The error correction term must have a negative sign with the coefficient value lies in between 0 and 1.

$$\begin{bmatrix} \Delta\ln \mathrm{EK} \\ \Delta\ln \mathrm{GDP} \\ \Delta\ln \mathrm{FD} \\ \Delta\ln \mathrm{K} \\ \Delta\ln \mathrm{URB} \\ \Delta\ln TR \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \end{bmatrix} + \begin{bmatrix} A_{11,1} & A_{12,1} & A_{13,1} & A_{14,1} & A_{15,1} & A_{16,1} \\ A_{21,1} & A_{22,1} & A_{23,1} & A_{24,1} & A_{25,1} & A_{26,1} \\ A_{31,1} & A_{32,1} & A_{33,1} & A_{34,1} & A_{35,1} & A_{36,1} \\ A_{41,1} & A_{42,1} & A_{43,1} & A_{44,1} & A_{45,1} & A_{46,1} \\ A_{51,1} & A_{52,1} & A_{53,1} & A_{54,1} & A_{55,1} & A_{56,1} \\ A_{61,1} & A_{62,1} & A_{63,1} & A_{64,1} & A_{65,1} & A_{66,1} \end{bmatrix} \times \begin{bmatrix} \Delta\ln \mathrm{EK}_{\text{t-1}} \\ \Delta\ln \mathrm{GDP}_{\text{t-1}} \\ \Delta\ln \mathrm{FD}_{\text{t-1}} \\ \Delta\ln \mathrm{K}_{\text{t-1}} \\ \Delta\ln \mathrm{URB}_{\text{t-1}} \\ \Delta\ln TR_{\text{t-1}} \end{bmatrix} + \ldots +$$

$$\begin{bmatrix} A_{11,n} & A_{12,n} & A_{13,n} & A_{14,n} & A_{15,n} & A_{16,n} \\ A_{21,n} & A_{22,n} & A_{23,n} & A_{24,n} & A_{25,n} & A_{26,n} \\ A_{31,n} & A_{32,n} & A_{33,n} & A_{34,n} & A_{35,n} & A_{36,n} \\ A_{41,n} & A_{42,n} & A_{43,n} & A_{44,n} & A_{45,n} & A_{46,n} \\ A_{51,n} & A_{52,n} & A_{53,n} & A_{54,n} & A_{55,n} & A_{56,n} \\ A_{61,n} & A_{62,n} & A_{63,n} & A_{64,n} & A_{65,n} & A_{66,n} \end{bmatrix} \times \begin{bmatrix} \Delta\ln \mathrm{EK}_{\text{t-1}} \\ \Delta\ln \mathrm{GDP}_{\text{t-1}} \\ \Delta\ln \mathrm{FD}_{\text{t-1}} \\ \Delta\ln \mathrm{K}_{\text{t-1}} \\ \Delta\ln \mathrm{URB}_{\text{t-1}} \\ \Delta\ln TR_{\text{t-1}} \end{bmatrix} + \begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \\ \omega_5 \\ \omega_6 \end{bmatrix} \times (ECM_{t-1}) +$$

$$\begin{bmatrix} \vartheta_{1t} \\ \vartheta_{2t} \\ \vartheta_{3t} \\ \vartheta_{4t} \\ \vartheta_{5t} \\ \vartheta_{6t} \end{bmatrix} \qquad (4.12)$$

This measures the speed of adjustment by which the short-run dynamics would converge back to its normal position after short-run shock. After examining the long-run relationship among the estimated variables, the Granger causality test is applied to determine the direction of causality between the estimated variables. If there is an evidence of cointegration among the estimated variables, then the VECM model can be written as in Equation 4.12. Where "Δ" represents the difference and "ECM_{t-1}"

represents the lagged error correction term. The coefficient of the error correction term must be negative and the value of the coefficient must be in between 0 and 1. The long-run causality is obtained by the significance of the lagged error correction term by considering the *t*-test statistics. The short-run causality is obtained by the significance of the lagged coefficients of the first difference variables. The joint *F*-statistics or Wald test is used to estimate the joint significance of the short-run coefficients.

4.3 Non-linear ARDL

This study also applies the non-linear ARDL to estimate the asymmetric non-linear short-run and long-run impact of electricity consumption (*EK*) on urbanisation (*URB)*, capital (*K*), GDP per capita (*GDP*), index of financial deepening (*FD*), Trade (*TR*). However, in non-ARDL the imports as a percentage of GDP and exports as a percentage of GDP will further be used to measure the trade openness. Therefore, it takes the following functional of the model and can be written as

$EK = f(GDP^{+},GDP^{-},FD^{+},FD^{-},K^{+},K^{-},URB^{+},URB^{-},TR^{+},TR^{-})$

Shin et al. (2014) proposed the nonlinear ARDL bounds testing approach is applied to examine the long-run and short-run dynamics. The NARDL bounds testing approach performs better in small samples (Pesaran et al., 2001). The NARDL model can be applied to any series regardless of the order of cointegration. However, it must be ensured that none of the variables must be *I*(2). Furthermore, Granger and Yoon (2002) in their study argued that if there is an evidence of cointegration in time series by using their positive and negative components. Then, in this case, the non-linear cointegration is applied to analyse the reasons for the non-linearity. The asymmetric effects of the estimated variables can be determined in both the short-run and long-run under the framework of NARDL by using the negative and positive partial sum decompositions. Furthermore, it also permits us to jointly analyse the issue of non-linearity and stationarity in the context of the error correction model. The non-linear cointegrating regression as proposed by Shin et al. (2014) and can be written as

$$y_t = \alpha^{+}x_t^{+} + \alpha^{-}x_t^{-} + \mu \qquad (4.13)$$

Where the coefficient α^{+} and α^{-} are the long-run parameters of $k \times 1$vector of regressors x_t that is decomposed as

$$x_t^{-} = x_o + x_t^{+} + x_t^{-} \qquad (4.14)$$

Where both the x_t^+ and $x_t^-$are the partial sum of positive, and partial sum of the negative, then the change in x_t can be as follows

$$J_t^+ = \sum_{k=1}^{t} \Delta j_l^+ = \sum_{k=1}^{t} \max(\Delta J_t, 0) \text{ and } J_t^- = \sum_{k=1}^{t} \Delta j_l^- = \sum_{k=1}^{t} \min(\Delta J_t, 0) \quad (4.15)$$

After decomposing the NARDL into positive and negative partial sums the NARDL with (p, q) in the form of asymmetric error correction model (ACEM) can be written as

$$\Delta Y_t = \partial_{t-1} + \theta_1^+ X_{t-1}^+ + \theta_1^- X_{t-1}^- + \sum_{k=1}^{p-1} \gamma_1 \Delta Y_{t-k} + \sum_{k=0}^{q} (\pi_k^+ \Delta X_{t-k}^+ + \pi_k^- \Delta X_{t-k}^-) + \mu_t \, (4.16)$$

Where θ^+= - $\partial\alpha^+$ and θ^-= - $\partial\alpha^-$. The above equation is used to determine the non-linear relationship among the estimated variable is the same as linear ARDL bounds testing approach by test the joint null ($\partial = \theta^+ = \theta^-$ =0) hypothesis. However, in NARDL the Wald test of joint significance is utilized to investigate the long-run and short-run asymmetries (θ^+=θ^-) and π^+=π^-. Finally the assymetric cumulative dynamic multiplies is applied to analyse the multiplier effect of the unit change in the both the $x_t^+ and\ x_t^-$is investigated on Y_t respectively using the following equations.

$mu_i^+ = \sum_{k=0}^{u} \frac{\delta y_{t+k}}{\delta x_t^+}$, $mu_i^- = \sum_{k=0}^{u} \frac{\delta y_{t+k}}{\delta x_t^-}$ where h → ∞ then $mu_i^+ \rightarrow \alpha^+$ and $mu_i^- \rightarrow \alpha^-$

It is pertinent to mention here that both α^+ and α^-represents the asymmetric long-run coefficients and can be computed as $\alpha^+ = \frac{-\theta^+}{\partial}$ and $\alpha^- = \frac{-\theta^-}{\partial}$ respectively.

4.4 Asymmetric causality test

To investigate the asymmetric causal relationship among the estimated variables in the model, this study applies the asymmetric causality test suggested by Hatemi-J (2012b) to investigate the asymmetric causal relationship among the estimated variables to investigate the asymmetric causal relationship among the two integrated variables, such as Z_{1t} and Z_{2t} the variables can be defined as following the random process as

$$Z_{1t} = Z_{1t} - 1 + \vartheta_{1t} = Z_{10} + \sum_{i=1}^{t} \vartheta_{1i} \quad (4.17)$$

$$Z_{2t} = Z_{2t} - 1 + \vartheta_{1t} = Z_{20} + \sum_{i=1}^{t} \vartheta_{2i} \ (4.18)$$

Where t=1, 2,…. T, Z_{10} and Z_{20} are the constants ϑ_{1i} and ϑ_{2i} are the error term that must be white noise. Both the positive and negative shocks can be written as $\vartheta_{1t}^{+} = \max(\vartheta_{1i}, o)$ and $\vartheta_{2t}^{+} = \max(\vartheta_{2i}, o)$, $\vartheta_{1t}^{-} = \min(\vartheta_{1i}, o)$ $\vartheta_{2t}^{-} = \min(\vartheta_{2i}, o)$. Therefore the residuals derived will be the sum of positive and negative shocks as $\vartheta_{1i} = \vartheta_{1i}^{+} + \vartheta_{1i}^{-}$ and $\vartheta_{2i} = \vartheta_{2i}^{+} + \vartheta_{2i}^{-}$. After decomposing into positive and negative shocks, then Z_{1t} and Z_{2t} can be written as

$$Z_{1t} = Z_{1t} - 1 + \vartheta_{1t} = Z_{10} + \sum_{i=1}^{t} \vartheta_{1i}^{+} + \sum_{i=1}^{t} \vartheta_{1i}^{-} \ (4.19)$$

$$Z_{2t} = Z_{2t} - 1 + \vartheta_{1t} = Z_{20} + \sum_{i=1}^{t} \vartheta_{2i}^{+} + \sum_{i=1}^{t} \vartheta_{2i}^{-} \ (4.20)$$

Finally, both the positive and negative shocks of each variable can be written as $Z_{1t}^{+} = \sum_{i=1}^{t} \vartheta_{1i}^{+}$and $Z_{1t}^{-} = \sum_{i=1}^{t} \vartheta_{1i}^{-}$ and $Z_{2t}^{+} = \sum_{i=1}^{t} \vartheta_{2i}^{+}$,$Z_{2t}^{-} = \sum_{i=1}^{t} \vartheta_{2i}^{-}$. After identifying the negative and positive shocks for each variable the next step is to estimate the causal relationship between the positive cumulative shocks and negative cumulative shocks. Let's assume that $\vartheta_{t}^{+} = \vartheta_{1}^{+}, \vartheta_{2}^{+}$, in order to analyse the causality among the two variables the following vector autoregressive model of order q can be written as

$$Z_{t}^{+} = v + S_{1} Z_{t-1}^{+} + \cdots . + S_{q} Z_{t-q}^{+} + \mu^{+} (4.21)$$

Where $Z_{t}^{+}$is 2×1 vector of variables, while v is the 2×1 vector of intercepts, and μ^{+} is the vector of residual term.

It is worth to mention here that Hatemi-J (2012b) adopted the procedure of Toda-Yamamoto principle (Toda and Yamamoto, 1995) to investigate the asymmetric causality among the variables. In this regards the Toda-Yamamoto procedure consists of three steps. In the first step, the maximum order of integration (d_{max}) among the series is computed using the unit root test. In the second step, the optimal lag length under the unrestricted VAR system (r) is computed by following the lag length criteria and the augmented VAR system must be analysed with (r+ d_{max}). In the third step a standard Wald test with an asymptotic (χ^2) distribution is employed to investigate the causal relationship among the variables. The model information criterion is used to select the optimal lag length in Hatemi-J (2012a, 2012b) as proposed by Hatemi-J (2003). The null hypothesis of no causality among the variables will be tested by Wald restrictions. Furthermore, the bootstrap simulation procedure is used to obtain the critical values with 10,000 replications.

CHAPTER FIVE

5. Empirical Results and Discussion

5.1. Unit Root Test Results

The empirical analysis of time series data always requires the integration level of the series to apply the appropriate cointegration test. The decision of integration of series is based on the unit root test.

Table 5.1.ADF unit root test

M	ADF			
Iceland (1965-2013)	L		1st Diff.	
	IN	IN & TR	IN	IN & TR
LnEKt	-1.8565 (1)	-3.0805 (1)	-4.7622*** (0)	-4.8481*** (0)
LnGDPt	-1.0269 (1)	-2.2065 (1)	-4.5138*** (0)	-4.4877*** (0)
$LnFD_t$	-1.0180 (1)	-1.9078 (1)	-4.2961*** (0)	-4.2369*** (0)
LnK_t	-1.2111 (1)	-3.1807 (1)	-5.3723*** (0)	-5.3276*** (0)
LnURBt	-81.9530*** (0)	-18.7763***(0)	-3.4668** (0)	-2.2693* (4)
$LnIMPO_t$	-1.8481 (1)	-1.8383 (0)	-6.6248*** (0)	-6.5847*** (0)
$LnEXPO_t$	-2.5241 (1)	-1.7657 (1)	-5.4739*** (0)	-5.4678*** (0)
LnTRt	-1.7927 (0)	-1.1630 (0)	-5.6247*** (0)	-5.6356*** (0)

Note: The ADF unit root tests have been performed with intercept and intercept and trend first at the level and then at first difference. (ii) The lag length was selected using the SBIC which is shown in the parenthesis. (iii) *, **, *** represents significance at 10%, 5%, and 1%. (iv) Where IN and TR represent the intercept and Trend.

Table 5.2.PP Unit root test

M	PP			
Iceland (1965-2013)	L		1st Diff.	
	IN	IN & TR	IN	IN & TR
LnEKt	-1.5144 (1)	-2.1953 (1)	-4.7947*** (1)	-4.8481*** (0)
LnGDPt	-1.4552 (2)	-1.7041 (1)	-4.5567*** (3)	-4.4107*** (4)
$LnFD_t$	-0.8407 (4)	-1.8688 (4)	-4.3656*** (3)	-4.3077*** (3)
LnK_t	-0.7512 (4)	-2.7270 (2)	-5.2731*** (6)	-5.2328*** (7)
LnURBt	-56.8794*** (3)	-13.0768*** (3)	-6.6168*** (11)	-1.3084 (5)
$LnIMPO_t$	-1.6911 (9)	-1.7789 (6)	-6.6384*** (3)	-6.5964*** (3)
$LnEXPO_t$	-2.1731 (0)	-1.7657 (1)	-5.4739*** (0)	-5.4678*** (0)
LnTRt	-1.8102 (7)	-1.0294 (8)	-5.5890*** (14)	-5.7641*** (20)

Note: (i) The PP unit root tests have been performed with Newey-West using Bartlett Kernel. (ii) The lag length was selected using the SBIC which is shown in the parenthesis. (iii) The unit root test has been performed with intercept and intercept and trend first at the level and then at first difference. (iv) *, **, *** represents significance at 10%, 5%, and 1%. "M" represents the models selected based on the more general to more specific.

Table 5.3.KPSS unit root test

M	L		1st Diff.	
Iceland (1965-2013)	IN	IN and TR	IN	IN and TR
LnEKt	0.8716*** (5)	0.4864*** (0)	0.2351 (0)	0.1100 (1)
LnGDPt	0.8692*** (5)	0.3312*** (1)	0.1710 (1)	0.0158 (1)
$LnFD_t$	0.8858*** (3)	0.2557*** (3)	0.1758 (3)	0.1065 (4)
LnK_t	0.8028*** (5)	0.2449*** (0)	0.0716 (0)	0.0563 (0)
LnURBt	0.7903** (5)	0.3323** (3)	0.8816*** (5)	0.2268*** (5)
$LnIMP_t$	0.9984*** (3)	0.3105*** (3)	0.1070 (0)	0.0431 (0)
$LnEXP_t$	0.9608*** (1)	0.2437*** (1)	0.1471 (1)	0.0400 (1)
LnTRt	0.9388*** (2)	0.2836*** (2)	0.2081 (2)	0.0508 (2)

Note: The table shows the unit root test results for KPSS. The Spectral estimation method selected is Bartlett Kernel, and the Newey-West method is used for bandwidth. Whereas *, **, *** represents significance at 10%, 5%, and 1% of the null hypothesis of stationary against the alternative hypothesis test of non-stationary in the KPSS test. Critical values for the KPSS test are from Kwiatkowski et al., (1992). Where IN and TR represent the intercept and Trend. "M" represents the models selected based on the more general to more specific.

Table 5.4.Unit root test with one Endogenous Structural Break

Variables	**Level**				
	AO -model	TB1	IO-model	TB1	Result
	t-Statistics		*t*-Statistics		
LnEKt	-2.508	2007	-2.821	1996	*I*(0)
LnGDPt	-1.873	1988	-2.732	1967	*I*(0)
$LnFD_t$	-3.547	2007	-2.918	1995	*I*(0)
LnK_t	-2.101	1985	-2.577	1981	*I*(0)
LnURBt	-3.853*	1986	-5.839*	1989	*I*(0)
$LnIMP_t$	-3.026	1977	-3.385	1974	*I*(0)
$LnEXP_t$	-3.806	1983	-3.403	1984	*I*(0)
LnTRt	-3.432	1983	-4.008	1984	*I*(0)
First Difference					
ΔLnEKt	-4.823*	1968	-7.509*	1969	*I*(1)
ΔLnGDPt	-5.410*	1981	-5.449*	2006	*I*(1)
$\Delta LnFD_t$	-4.268*	2003	-5.594*	2005	*I*(1)
ΔLnK_t	-6.119*	2007	-6.731*	2008	*I*(1)
ΔLnURBt	-2.710	1991	-3.656	1969	*I*(0)
$\Delta LnIMP_t$	-7.060*	1994	-4.591*	1995	*I*(1)
$\Delta LnEXP_t$	-6.859*	2007	-6.866*	2006	*I*(1)
ΔLnTRt	-6.391*	1970	-6.146*	1971	*I*(1)

Note: * represents the significance at 1% level. TB1 represents the break dates of Perron and Vogelsang.

Traditionally, the conventional cointegration tests like Johansen and Juselius (1990), Bayar-Hanck (2013) combine cointegration tests can only be applied to the series having a unique order of integration. However, ARDL bounds test of cointegration test is applied regardless of cointegration whether, the underlying regressors are $I(0)$, $I(1)$ or a mixture of $I(0)$, $I(1)$, but it must be ensured that none of the variables must be $I(2)$. The computed test statistics turns to be invalid if one of the variables in a series is integrated of order I (2). This study applies the Augmented Dickey-Fuller unit root test (ADF) from Dickey and Fuller (1979), Phillips-Peron (PP), and KPSS from Kwiatkowski et al. (1992). The results of the unit root test have been shown in Table 5.1-5.3. The above-mentioned unit root test is applied to the natural logarithms of the respective variables to investigate the order of integration. It was found that all the variables except urbanisation are found to be non-stationary at level. But they become stationary by taking the first difference. However, urbanisation is stationary at level. The Phillips-Peron (PP), and KPSS unit root test confirm the results those obtained from ADF unit root test. This implies that all the variables are $I(1)$ except urbanisation which is integrated at the level $I(0)$. As urbanisation is independent variable and the dependent variable is electricity consumption. The same results have been confirmed by Perron and Vogelsang (1992) in Table 5.4. Thus, ARDL approach to cointegration can be applied in this case which is having mixed order of integration of series. The study applies ARDL bounds testing of cointegration using the Joint F-statistics or Wald for possible evidence of cointegration. The computed F-Statistics or Wald test is then compared with the $I(0)$ and $I(1)$ critical values obtained from Pesaran et al. (2001). The results of the ARDL bounds test of cointegration has been shown in Table 5.5. The optimal lag length was selected via the AIC criterion using restricted intercept and no trend (Case 2). The results from Table 5.5 revealed that the calculated F-Statistics is higher than the upper bounds critical values, thus rejecting the null hypothesis of no cointegration. However, an alternative way of long-run association ship among the estimated variables is invested by observing the value of the lagged error correction term of the cointegrating equation (ECT_{t-1}). Banerjee et al. (1998) argued in his study that the coefficient of the lagged error correction term must be negative and statistically significant, with the coefficient value lies in between 0-1. This implies that evidence of cointegration amongst the estimated variables in the model. Alternatively, the estimated variables are in a long-run association ship among each other. Thus in Table 5.5 the values of the lagged error correction term (ECT_{t-1}) has been showed to check the robustness of F-statistics value. This further implies that in all cases both the lagged error correction term (ECT_{t-1}) and F-Statistics value are reinforcing each other showing a strong evidence of cointegration among the estimated variables in the model including imports, export and trade. Furthermore, the diagnostic tests for the ARDL bounds testing of cointegration have also been showed in Table 5.5. The results for the heteroscedasticity, serial correlation LM test, Ramsey rest test to investigate the stability of the models. It was found that in all the models the residuals are having no problem of serial correlation and heteroscedasticity. Furthermore, the Ramsey reset test suggests the evidence of stability in all the models.

5.2. ARDL long-run results and Short-run Results

Table 5.6 shows long-run results under the framework of ARDL model for both linear and non-linear specification. In Table 5.6 the impact of financial development, urbanisation, economic growth, capital and trade (Imports and exports) on electricity consumption in the long-run. We noted that financial development has a positive and statistically significant impact on electricity consumption. This implies that by keeping other things constant, a 1% increase in financial development will cause an increase in the electricity demand by 0.0435% and 0.0269% respectively in the model including exports and trade. These findings of our study are in concordance with the past studies such as Sadorsky (2011) conducted a study for Central and Eastern Europe, Shahbaz (2015) and Coban and Topcu (2013) for European countries for Pakistan. GDP appears to be positively linked with the electricity consumption, however, its impact is insignificant in all models including imports, exports and trade. Capital is positively and significantly linked with the electricity consumption. This implies that by keeping other things constant, a 1% increase in the physical capital will cause the electricity demand to be rise by 0.5824%, 1.0865% and 0.7190% respectively.

Table 5.5.Results of Bounds test of Co-integration with long-run diagnostic tests.

Models used to investigate cointegration [5]	AIC Lag length	*F*-Statistics	Break[6] date	ECT_{t-1} (*t*-statistics)	χ^2_{SC}	χ^2_{HA}	χ^2_{HB}	χ^2_{N}	Ramsey Reset Test *F*-Statistics
F_{LnEK}*(LnEK/LnGDP,LnIMP,LnFD,LnK,LnURB)*	(1,0,1,2,2,0)	13.2696*	2007	-0.4211 (-10.4312)	4.9573 (0.0839)	0.1731 (0.6773)	17.0885 (0.1053)	6.1906 (0.0452)	3.9165 (0.0560)
F_{LnGDP}*(LnGDP/LnEK,LnIMP,LnFD,Ln K,LnURB)*	(2,0,0,0,0,2)	8.4565*	1988	-0.4633 (-8.2942)	0.1474 (0.9289)	0.4033 (0.5253)	4.7433 (0.8560)	0.1571 (0.9244)	0.1604 (0.6911)
F_{LnIMP}*(LnIMP/LnEK,LnGDP,LnFD,LnK,LnURB)*	(2,0,0,0,1,1)	4.3376*	1977	-0.5956 (-5.9403)	3.2665 (0.1953)	0.5073 (0.4763)	17.1589 (0.0463)	0.10045 (0.9510)	5.1239 (0.0297)
F_{LnFD}*(LnFD/LnEK,LnIMP,LnGDP,LnK,LnURB)*	(1,2,0,1,1,2)	6.1345*	2007	-0.0844 (-7.1077)	2.9765 (0.2258)	5.4157 (0.0200)	25.1047 (0.0143)	0.0540 (0.9733)	0.6149 (0.4385)
F_{LnK} *(LnK/LnEK,LnIMP,LnFD,LnGDP,LnURB)*	(1,2,1,2,2,1)	5.6038*	2007	-0.4246 (-6.8250)	0.1954 (0.9069)	0.0005 (0.9811)	19.9456 (0.1319)	0.9904 (0.6094)	0.2638 (0.6111)
F_{LnURB}*(LnURB/LnEK,LnIMP,LnFD,LnK,LnGDP)*	(2,2,0,2,0,0)	3.8814**	1986	-0.0311 (-5.6415)	1.8675 (0.3931)	0.4908 (0.4836)	17.7182 (0.0884)	13.0184 (0.0014)	0.0297 (0.8641)
F_{LnEK}*(LnEK/LnGDP,LnEXP,LnFD,LnK,LnURB)*	(2,0,0,2,2,0)	12.0996*	2007	-0.4392 (-9.9607)	1.2411 (0.5376)	0.3044 (0.5811)	13.9346 (0.2366)	8.4503 (0.0146)	2.3718 (0.1328)
F_{LnGDP}*(LnGDP/LnEK,LnEXP,LnFD,Ln K,LnURB)*	(2,0,1,0,0,2)	8.8366*	1988	-0.3934* (-8.4950)	0.5830 (0.7471)	0.0336 (0.8544)	6.4820 (0.7733)	0.3332 (0.8465)	0.2662 (0.6091)
F_{LnEXP}*(LnEXP/LnEK,LnGDP,LnFD,LnK,LnURB)*	(1,0,0,2,0,1)	8.0460*	1983	-0.6131* (-8.0904)	1.2920 (0.5241)	3.3125 (0.0688)	11.6587 (0.2332)	1.4954 (0.4734)	0.5094 (0.4800)

[5] The above mentioned are analysed using the second case with unrestricted intercept and without trend. The variables are used in the ARDL model as the same as in line with the lag length as identified lag length column selected through AIC. Further, more each variable in the model has been identified as individual lag length in the same column.
[6] The break dates are based on (AO) model of Perron–Vogelsang test (1998).

F_{LnFD}(LnFD/LnEK,LnEXP,LnGDP,LnK,LnURB)	(1,0,0,1,1,0)	5.7532*	2007	-0.0306* (-6.8168)	0.8619 (0.6499)	1.4142 (0.2344)	15.1132 (0.0570)	0.3571 (0.8364)	1.1088 (0.2990)
F_{LnK} (LnK/LnEK,LnEXP,LnFD,LnGDP,LnURB)	(1,2,0,2,2,2)	11.0522*	2007	-0.6273* (-9.5847)	1.5166 (0.4685)	0.1081 (0.7423)	11.7866 (0.6233)	2.2736 (0.3208)	0.0091 (0.9246)
F_{LnURB}(LnURB/LnEK,LnEXP,LnFD,LnK,LnGDP)	(2,2,0,2,0,0)	3.9966**	1986	-0.0300 (-5.7246)	1.2833 (0.5264)	0.5779 (0.4471)	18.3905 (0.0729)	11.5280 (0.0031)	0.0147 (0.9039)
F_{LnEK}(LnEK/LnGDP,LnTR,LnFD,LnK,LnURB)	(2,0,3,2,2,0)	13.2322*	2007	-0.5711* (-10.5144)	0.8086 (0.6674)	1.9090 (0.1671)	23.7798 (0.0487)	0.4408 (0.8021)	3.1488 (0.0861)
F_{LnGDP}(LnGDP/LnEK,LnTR,LnFD,Ln K,LnURB)	(2,0,1,0,0,1)	8.4375*	1988	-0.4054* (-8.2849)	0.8894 (0.6410)	0.7034 (0.4016)	3.6977 (0.9302)	0.0786 (0.9614)	0.0020 (0.9642)
F_{LnTR}(LnTR/LnEK,LnGDP,LnFD,LnK,LnURB)	(1,0,0,0,0,1)	4.6359*	1983	-0.3667* (-6.1089)	1.7091 (0.4255)	2.9800 (0.0843)	3.5471 (0.8302)	0.6233 (0.7322)	1.1369 (0.2929)
F_{LnFD}(LnFD/LnEK,LnTR,LnGDP,LnK,LnURB)	(1,0,0,1,1,0)	5.4795*	2007	-0.0298* (-6.6526)	1.7337 (0.4203)	1.2103 (0.2713)	14.5213 (0.0691)	0.4340 (0.8049)	1.4225 (0.2404)
F_{LnK} (LnK/LnEK,LnTR,LnFD,LnGDP,LnURB)	(1,2,1,2,2,2)	7.1861*	2007	-0.5418* (-7.7485)	3.0567 (0.2169)	0.1934 (0.6601)	19.5933 (0.1881)	0.5397 (0.7634)	0.0148 (0.9038)
F_{LnURB}(LnURB/LnEK,LnTR,LnFD,LnK,LnGDP)	(2,2,0,2,0,0)	3.9651**	1986	-0.0308* (-5.7021)	1.6845 (0.4307)	0.6337 (0.4260)	18.63404 (0.0860)	11.4671 (0.0032)	0.0423 (0.8382)
Critical Values	1 Percent		2.5 Percent				5 Percent		10 Percent
Lower Bounds I (0)	3.06		2.7				2.39		2.08
Upper Bounds I (1)	4.15		3.73				3.38		3.00

Source: Author's own computation

Table 5.6.ARDL Long-run results (Linear and Non-linear)

Dependent Variable: $LnEK_t$	**Long-run results (ARDL FRAME WORK) Linear Specification**								
	Imports model			**Exports model**			**Trade model**		
Variable	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat
Constant	28.8924	9.7861	2.9523*	30.0554	8.8914	3.3802*	33.0112	8.4813	3.8922*
LnGDPt	0.1716	0.5704	0.3008	0.3153	0.4810	0.6555	0.0642	0.4397	0.1461
$LnIMP_t$	1.4209	0.3704	3.8356 *	-----	-----	-----	-----	-----	-----
$LnFD_t$	0.0197	0.0232	0.8495	0.0435	0.0172	2.5281*	0.0269	0.0151	1.7830*
LnK_t	0.5824	0.2372	2.4553*	1.0865	0.2525	4.3025*	0.7190	0.1803	3.9877*
$LnExp_t$	-----	-----	-----	1.1794	0.2600	4.5353*	-----	-----	-----
LnURBt	27.5576	7.1539	3.8520*	28.3538	6.3892	4.4377*	30.77204	6.2874	4.8942*
$LnTR_t$	-----	-----	-----	-----	-----	-----	1.7197	0.3319	5.1807*
R^2	0.9927			0.9942			0.9944		
Adj. R^2	0.9904			0.9923			0.9918		
F-Stat.	436.4604			546.8397			393.6265		
S.E of Reg	0.0687			0.0614			0.0596		
SSR	0.1652			0.1320			0.1103		
D.W	1.67			2.08			1.88		
Long-run results (ARDL FRAMEWORK) Non- Linear Specification									
Variable	Coefficient	Stan Error	t-Stat	Coefficient	Standard Error	t-Stat	Coefficient	Standard Error	t-Stat
Constant	29.0950	11.1826	2.6017*	29.0545	9.0192	3.2213*	32.5298	10.8139	3.0081*
LnGDPt	-0.5775	0.7648	-0.7550	0.4730	0.5355	0.8833	-0.5908	0.7071	-0.8355
$LnIMP_t$	1.1201	0.3382	3.3115*	-----	-----	-----	-----	-----	-----
$LnFD_t$	0.0769	0.0420	1.8281*	0.0531	0.0236	2.2481*	0.0861	0.0369	2.3321*
$LnFD_t^2$	0.0140	0.0105	1.3295	-0.0059	0.0094	-0.6292	0.0111	0.0099	1.1191
LnK_t	0.1172	0.2079	0.5636	1.1458	0.2763	4.1468*	0.4747	0.2243	2.1156*
$LnExp_t$	-----	-----	-----	1.1948	0.2642	4.5210*	-----	-----	-----
LnURBt	23.2928	8.0880	2.8798*	27.4936	6.5205	4.2164*	26.5122	7.8828	3.3632*
$LnTR_t$	-----	-----	-----	-----	-----	-----	1.6568	0.3523	4.7025*
Adj. R^2	0.9925			0.9942			0.9955		
F-Stat.	344.0783*			492.7060*			353.8628*		
D.W	2.40			2.08			2.35		

Note: * represents significance at 10%.

The positive and statistically significant impact of capital on electricity consumption is in concordance with the studies by Rafindadi and Ozturk (2106) for Japan. The impact of urbanisation on electricity consumption is positive and statistically significant at 10%. This suggests that 1% rise in urbanisation (migration to the urban area) will cause the electricity demand to increase by 27.55%, 28.35%, and 30.77% respectively. This implies that urbanisation appears to be the driver of electricity demand. Nearly 92% of the Iceland population are living in the urban areas. This has caused an upsurge in demand for the electricity consumption in the recent decades in Iceland. The Iceland imports on other hand were positively and statically significant with the electricity demand. This implies by keeping other things constant, a 1% rise in imports will cause the upsurge in the electricity demand by 1.4209%. Similarly, the Iceland exports are also positively and statistically linked with the electricity demand. The long-run results suggest that 1% rise in the Iceland exports will lead to 1.1948% rise in electricity demand. Likewise, trade openness also has a positive and statistically significant on electricity demand at 10%. Further, the squared term of financial Deeping is investigated to analyse its impact on electricity consumption. We noted an inverted U-shaped relationship between financial Deeping and electricity consumption but insignificant in the export model. This suggests that financial Deeping has little or no role in delinking of electricity consumption and financial development at the higher level of financial system development. This further implies that the Government of Iceland after allocating financial resources doesn't monitor the projects well that encourages the firms to utilise efficient technology to decrease the consumption of electricity. The diagnostic tests for the long-run coefficients have been reported in Table 5.5. The results showed the absence of serial correlation among the residuals, and heteroscedasticity. The residuals of Q-statistics are white noise that implies the validity of the classical linear regression model assumptions. Finally, R-square and adjusted R-square is high enough in all cases that suggest the joint explanation of the change of the independent variable in the dependent variable. Furthermore, the F-Statistics in both Panel A and Panel B are statistically significant that implies the validity of models in our case.

The results of the short-run analysis are reported in Table 5.7 and Table 5.8 for both linear and non-linear along with the short –run diagnostic test. The results imply that capital is positively and statistically significant only in the export model in both linear and non-linear specifications. This suggests that a 1% rise in physical capital would upsurge the demand for electricity consumption by 0.3439% and 0.3558% respectively. The impact of economic growth is insignificant and negative in both linear and non-linear models in the short-run. This development is a contrast with the long-run results where we found statistically positive and relationship.

The effect of financial Deeping index has an insignificant effect on electricity in the linear model. However, a positive and significant impact of financial Deeping on electricity consumption in import and trade model was revealed in a non-linear model.

Table 5.7.ARDL Short-run results (Linear)

Dependent Variable: $LnEK_t$									
Short-run results (ARDL FRAMEWORK)									
Linear Specification									
Import model				**Export model**			**Trade model**		
Variable	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat
$\Delta LnIMP_t$	0.1726	0.1983	0.8705	-----	-----	-----	-----	-----	-----
$\Delta LnGDP_t$	0.0722	0.2470	0.2925	0.1385	0.2223	0.6231	0.0367	0.2523	0.1454
$\Delta LnFD_t$	-0.0505	0.0336	-1.5016	-0.01898	0.0312	-0.6076	-0.0430	0.0306	-1.4076
ΔLnK_t	0.1603	0.1219	1.3151	0.3439	0.1008	3.4118*	0.2601	0.1058	2.4572*
$\Delta LnExp_t$	-----	-----	-----	0.5180	0.1126	4.6000*	-----	-----	-----
$\Delta LnURBt$	11.6047	2.7957	4.1508*	12.4530	2.5601	4.8641*	17.5745	4.0131	4.3792*
$\Delta LnTR_t$	-----	-----	-----	-----	-----	-----	0.3385	0.1863	1.8169*
ECM_{t-1}	-0.4211	0.0403	-10.4312	-0.4392	0.0440	-9.9607	-0.5711	0.0543	-10.5144*
R^2	0.6415			0.7134			0.7585		
Adj. R^2	0.5978			0.6785			0.7063		
F-Stat.	10.7564*			10.9006*			10.6245*		
D.W	1.67			2.08			1.88		
Short-run Diagnostic tests	F-Statistics	Probability		F-Statistics	Probability		F-Statistics		Probability
χ^2_{SC}	2.1676	0.1284		1.3051	0.2830		0.2010		0.8188
χ^2_{H}	2.0300	0.0840		2.1366	0.0766		1.4708		0.1961
χ^2_{AR}	0.3827	0.5393		0.2253	0.6373		1.32E-07		0.9997

Note: * and ** shows significance at 1% and 5% respectively.

Table 5.8.ARDL Short-run results (Non-linear)

Dependent Variable: $LnEK_t$									
Short-run results (ARDL FRAMEWORK)									
Non-Linear Specification									
Import model				**Export model**			**Trade model**		
Variable	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat	Coefficient	Stan. Error	t-Stat
$\Delta LnEK_{t-1}$	0.0213	0.0914	0.2337	0.1560	0.0796	1.9604*	-0.0189	0.0870	-0.2174
$\Delta LnGDP_t$	-0.2741	0.3045	-0.9001	0.2078	0.2496	0.8327	-0.3460	0.2993	-1.1559
$\Delta LnIMP_t$	-0.0171	0.1324	-0.1291	-----	-----	-----	-----		
$\Delta LnFD_t$	0.0312	0.0137	2.2736*	-0.0178	0.0315	-0.5652	0.0377	0.0124	3.0377*
$\Delta LnFD^2$	-0.0098	0.0040	-2.4486*	-0.0026	0.0041	0.6322	-0.0108	0.0040	-2.6935*
ΔLnK_t	0.0950	0.0882	1.0766	0.3558	0.1034	3.4410*	0.0976	0.0694	1.4059
$\Delta LnExp_t$	-----	-----	-----	0.5250	0.1141	4.6002*	-----	-----	-----
$\Delta LnURBt$	9.4715	3.0938	3.0164*	12.0806	2.6487	4.5609*	11.6073	3.3369	3.4784*
$\Delta LnTR_t$	-----	-----	-----	-----	-----	-----	0.0329	0.1337	0.2464
ECM_{t-1}	-0.4066	0.0354	-11.4696*	-0.4393	0.0437	-10.0431*	-0.4378	0.0391	-11.1702*
R^2	0.8210			0.7167			0.8373		
Adj. R^2	0.7614			0.6822			0.7894		
F-Stat.	13.7675*			10.7718*			13.9093*		
D.W	2.28			2.08			2.35		
Short-run Diagnostic tests	F-Statistics	Probability		F-Statistics	Probability		F-Statistics	Probability	
χ^2_{SC}	0.8895	0.4211		1.5523	0.2249		0.3585	0.7015	
χ^2_{H}	1.3635	0.2358		2.2303	0.0598		1.4739	0.1883	
χ^2_{AR}	0.0022	0.9623		0.1643	0.6871		0.1167	0.7343	
χ^2_{N}	1.1702	0.5570		8.5164	0.01414		1.0361	0.5956	

Note: * and ** shows significance at 1% and 5% respectively.

This suggests that 1% rise in financial development may cause an increase in demand for electricity by 0.0312% and 0.0377% respectively. However, the coefficient of financial development in the export model is negative but statistically insignificant same. Furthermore, the squared of the financial Deeping is used to investigate its impact on electricity consumption in the short-run as well. An inverted U-shaped relationship between electricity consumption and financial Deeping was confirmed in import and trade openness model. This indicates that a 1% increase in financial deepening index may cause an increase in electricity demand by -0.0098% and -0.0108% respectively. However, the negative sign of the non-linear implies the delinking of electricity consumption and financial development at the much improved level of financial development. This further implies that initial point, the financial development contributes to the electricity demand by allocating of financial support to the productive ventures. But, after reaching a threshold level, the financial sector evaluates her allocated funds by motivating the firms to adopt efficient energy technology that will cause a decrease in demand electricity consumption. In such cases, the demand for electricity consumption declines. These findings of our study are in concordance with the findings as reported by (Shahbaz, 2013a, b) and Kumar et al. (2016) in their studies for long-run. It was further noted a positive and statistically significant relationship of urbanisation on electricity demand in both linear and non-linear models. Furthermore, both export and trade have a positive and statistically significant impact on electricity demand. This implies that more electricity is consumed to manufacture local products that are exported to other countries. The Iceland economy is more export oriented rather than relying too much on imports. The coefficients of ECM is found to be negative and statistically significant in both linear and non-linear model for import, exports and trade openness. The coefficient of the error correction estimates in the linear model is -0.4211, -0.4392, and -0.5711 while for the non-linear model is -0.4066, -0.4393, -0.4378 respectively. This further implies that the short-run deviations towards the long-run are corrected back to 0.4211%, 0.4392%, 0.5711% in the linear model, and -0.4066%, -0.4393%, and -0.4378% for non-linear specification in import, export, and trade openness model respectively.

Finally, the diagnostic tests were conducted for both linear and non-linear specifications. The results suggest the absence of serial correlation and heteroscedasticity among the residuals. The stability of the short-run coefficients is evaluated using CUSUM and (CUSUMSq) as proposed by Brown et al. (1975). All the CUSUM and CUSUMsq plot lies within the range of critical bounds at 5%. This further implies the stability of our estimated short-run coefficients for the period 1965-2013. Given the above explanation regarding the short-run and long-run analysis followed by the diagnostic and stability tests, it is important to analyse the direction of causality among the estimated variables. Using this motivation this study applies vector error correction model to investigate both the short-run and long-run causal relationship that can only be applied to the cointegrated series. The direction of causal relationship between the estimated variables helps us in crafting some appropriate policies to control electricity demand for sustainable growth.

5.3. VECM Causality results

The results under the framework of VECM[7] is reported in Table 5.9-5.11 Our empirical estimations indicate that the coefficient of ECT_{t-1} is negative and statistically significant in electricity equation, import equation, and capital equation. This further implies the evidence of bidirectional long-run relationship among electricity consumption and imports, electricity consumption and capital and import and capital in the long-run. This suggests that raising the capital of consumers causes the imports of more electrical home appliances that causes in an increase consumption of the electricity. The causality results indicate a bi-directional causality among urbanisation and electricity consumption. This implies the validity of feedback causality between urbanisation and electricity consumption in the short-run. This further suggests that inflow of population is rapid to the urban areas in Iceland since the demand for the electricity consumption is on rising Furthermore, three unidirectional causalities has been found that run from financial development to electricity consumption, imports and capital.

[7] Long-run equation extracted from VECM using import proxy to measure the TO as
LnEk= $+23.9096^{*} + 0.8106^{*}$ ln K $+1.2195^{*}$ ln IMP+ 0.6668^{*} ln GDP + 0.0146^{*} ln FD +26.1374* ln URB (Lag 1 was selected on the basis of Schwarz criterion that selects the most parsimonious model)
Long-run equation extracted from VECM using Export as proxy to measure the TO as
LnEk= $+12.3186^{*} + 1.0096^{*}$ ln K $+0.9394^{*}$ ln EXP+ 1.5034^{*} ln GDP + 0.0030^{*} ln FD+ 3.7806* ln URB (Lag 1 was selected on the basis of Schwarz criterion that selects the most parsimonious model)
Long-run equation extracted from VECM using trade as proxy to measure the TO as
LnEk= $+21.0235^{*} + 0.9686^{*}$ ln K $+1.1788^{*}$ ln TR+ 0.8921^{*} ln GDP + 0.0053^{*} ln FD+ 18.0124* ln URB (Lag 1 was selected on the basis of Schwarz criterion that selects the most parsimonious model)
It is necessary to mention here, that the sign of these long-run equations extracted from VECM is in concordance with the signs of the long-run results obtained under ARDL framework. The causal relationship was thus performed using the same three models.

Table 5.9. Granger causality test results using import as proxy for trade openness.

D.Vs	*F*-Stat. (corresponding *P*-values)						long-run	Joint causality including both long-run and short-run *F*-Stat. (corresponding *P*-values)					
	$\Delta LnEK_{t-1}$	$\Delta LnGDP_{t-1}$	$\Delta LnIMP_{t-1}$	$\Delta LnFD_{t-1}$	ΔLnK_{t-1}	$\Delta LnURB_{t-1}$	ECT_{t-1} [*t*-stat.]	$\Delta LnEK_{t-1}$. ECT_{t-1}	$\Delta LnGDP_{t-1}$ .ECT_{t-1}	$\Delta LnIMP_{t-1}$ .ECT_{t-1}	$\Delta LnFD_{t-1}$. ECT_{t-1}	ΔLnK_{t-1}. ECT_{t-1}	$\Delta LnURB_{t-1}$. ECT_{t-1}
ΔLnEK	------	0.0361 (0.8502)	0.6639 (0.4201)	4.534** (0.0396)	5.5370** (0.0238)	3.3443*** (0.0751)	-0.2941* [-4.6626]	--------	11.1870* (0.0001)	11.3873* (0.0001)	10.9513* (0.0002)	12.0916* (0.0001)	12.5029* (0.0001)
ΔLnGDP	2.5838 (0.1160)	------	0.0097 (0.9218)	0.0151 (0.9027)	0.0728 (0.7887)	0.0200 (0.8882)	-0.0012 [-0.0662]	1.2922 (0.2861)	-------	0.0073 (0.9927)	0.0075 (0.9925)	0.0365 (0.9641)	0.0122 (0.9878)
ΔLnIMP	0.1076 (0.7446)	0.2126 (0.6473)	-------	6.1253* (0.0178)	0.3310 (0.5684)	0.0230 (0.8801)	-0.1980* [-2.7826]	3.9054* (0.0284)	3.8787* (0.0291)	------	4.5671* (0.0165)	4.4524* (0.0181)	3.8851* (0.0289)
ΔLnFD	1.0764 (0.3059)	1.9105 (0.1748)	1.0454 (0.3129)	-------	0.2443 (0.6239)	0.6651 (0.4197)	-0.0004 [-0.1075]	0.5416 (0.5861)	1.0367 (0.3642)	0.5247 (0.5958)	------	0.1415 (0.8685)	0.3387 (0.7147)
ΔLnK	0.6129 (0.4384)	5.2796* (0.0270)	0.0303 (0.8627)	8.2190* (0.0067)	-------	0.2907 (5928)	-0.2698* [-3.6916]	7.1950* (0.0022)	8.0384* (0.0012)	6.8141* (0.0029)	7.3903* (0.0019)	------	6.9688* (0.0026)
ΔLnURB	9.0191* (0.0046)	0.9747 (0.3296)	0.3225 (0.5733)	1.0653 (0.3083)	3.5943** (0.0654)	--------	0.0006 [0.3034]	4.5361* (0.0169)	0.6224 (0.5418)	0.2151 (0.8074)	1.0355 (0.3646)	1.7975 (0.1792)	------

Note: *, ** and *** represents the statistical significance level at 1%, 5% and 10% respectively.
The value in the square brackets represents the T-Statistics for the error correction term. While the probability values have been shown in parenthesis. The lag criterion was utilised to select the optimal lag. Lag 1 was selected based on SIC. The residual serial correlation LM test was performed and found the absence of serial correlation. The D.Vs correspond the dependent variables.

Also, unidirectional causality has been found from capital to electricity consumption and urbanisation. For export as an indicator of trade openness, it was found that coefficient of ECT_{t-1} is negative and statistically significant in electricity consumption equation and capital formation equation. This further implies that there is an evidence of a bi-directional relationship between electricity consumption and capital. Furthermore, similar joint bi-directional causality was also found. However, a short-run unidirectional causality has been found that runs from export to economic growth validating the export-led growth hypothesis. A uni-directional causality was also found from economic growth to capital and financial development

Table 5.10.Granger causality test results using export as proxy for trade openness.

D.Vs	*F*-Stat. (corresponding *P*-values)						long-run	Joint causality including both long-run and short-run *F*-Stat. (corresponding *P*-values)					
	$\Delta LnEK_{t-1}$	$\Delta LnGDP_{t-1}$	$\Delta LnEXP_{t-1}$	$\Delta LnFD_{t-1}$	ΔLnK_{t-1}	$\Delta LnURB_{t-1}$	ECT_{t-1} [*t*-stat.]	$\Delta LnEK_{t-1}.ECT_{t-1}$	$\Delta LnGDP_{t-1}.ECT_{t-1}$	$\Delta LnEXP_{t-1}.ECT_{t-1}$	$\Delta LnFD_{t-1}.ECT_{t-1}$	$\Delta LnK_{t-1}.ECT_{t-1}$	$\Delta LnURB_{t-1}.ECT_{t-1}$
ΔLnEK	------	0.1131 (0.7384)	3.5082 (0.0686)	1.0484 (0.3122)	0.2028 (0.6549)	6.1721 (0.0174)	-0.2808* [-3.2291]	--------	6.1694* (0.0047)	9.5427* (0.0004	5.7762* (0.0064)	5.2148* (0.0098)	7.6816* (0.0015)
ΔLnGDP	0.3091 (0.5814)	------	6.4236* (0.0154)	1.9507 (0.1704)	1.7029 (0.1995)	2.6508 (0.1115)	-0.0799 [0.1386]	1.5402 (0.2271)	-------	3.5384** (0.0387)	1.3435 (0.2727)	1.7311 (0.1904)	1.3428 (0.2729)
ΔLnEXP	0.2728 (0.6044)	7.4327* (0.0095)	-------	0.0077 (0.9301)	0.7696 (0.3857)	1.7470 (0.1939)	0.1255 [1.3767]	0.9766 (0.3856)	3.7194* (0.0332)	------	1.3360 (0.2746)	1.1739 (0.3198)	0.9477 (0.3964)
ΔLnFD	0.2959 (0.5895)	0.6417 (0.4279)	1.6556 (0.2058)	-------	0.4460 (0.5082)	2.0161 (0.1636)	0.0014 [1.2215]	1.0796 (0.3497)	1.9959 (0.1495)	1.2192 (0.3065)	------	0.8636 (0.4295)	1.1394 (0.3304)
ΔLnK	2.2997 (0.1375)	10.2982* (0.0027)	0.5923 (0.4461)	9.5897* (0.0036)	------	15.4697 (0.0003)	-0.4720* [-3.9577]	8.0813* (0.0012)	8.9466* (0.0006)	7.9125* (0.0013)	8.3007* (0.0010)	------	7.9435* (0.0013)
ΔLnURB	9.1567* (0.0044)	0.7837 (0.3814)	0.9125 (0.3453)	1.1394 (0.2923)	2.0018 (0.1650)	------	0.0001 [0.4587]	5.1993* (0.0100)	0.8988 (0.4153)	0.7532 (0.4775)	1.4575 (0.2452)	1.0304 (0.3664)	------

Note: * represents the statistical significance level at 1%.The value in the square brackets represents the T-Statistics for the error correction term. While the probability values have been shown in parenthesis. The lag criterion was utilised to select the optimal lag. Lag 1 was selected based on SIC. The residual serial correlation LM test was performed and found the absence of serial correlation. The D.Vs correspond the dependent variables.

Table 5.11.Granger causality test results using trade as proxy for trade openness.

D.Vs	*F*-Statistics (Probability)						long-run	*F*-Stat. (corresponding *P*-values) long-run					
	$\Delta LnEK_{t-1}$	$\Delta LnGDP_{t-1}$	$\Delta LnTR_{t-1}$	$\Delta LnFD_{t-1}$	ΔLnK_{t-1}	$\Delta LnURB_{t-1}$	ECT_{t-1} [*t*-stat.]	$\Delta LnEK_{t-1}$. ECT_{t-1}	$\Delta LnGDP_{t-1}$ .ECT_{t-1}	$\Delta LnTR_{t-1}$ .ECT_{t-1}	$\Delta LnFD_{t-1}$. ECT_{t-1}	ΔLnK_{t-1}. ECT_{t-1}	$\Delta LnURB_{t-1}$. ECT_{t-1}
$\Delta LnEK_t$	------	0.0583 (0.8104)	1.7965 (0.1879)	3.1328*** (0.0845)	4.7541** (0.0353)	5.1947* (0.0282)	-0.3159* [-4.3290]	--------	10.2594* (0.0003)	11.9751* (0.0001)	9.6047* (0.0004)	10.5276* (0.0002)	11.5991* (0.0001)
$\Delta LnGDP_t$	1.4216 (0.2403)	------	1.5246 (0.2243)	0.1393 (0.7110)	0.0146 (0.9043)	0.2043 (0.6538)	-0.0080 [-0.2757]	0.7704 (0.4697)	-------	0.7625 (0.4733)	0.0734 (0.9293)	0.0411 (0.9598)	0.1142 (0.8923)
$\Delta LnTR_t$	0.0775 (0.7822)	1.8919 (0.1768)	-------	2.2856 (0.1386)	1.3916 (0.2453)	0.2534 (0.6175)	-0.0361 [-0.5508]	0.2000 (0.8195)	1.5426 (0.2266)	------	1.1937 (0.3139)	0.9731 (0.3869)	0.1563 (0.8558)
$\Delta LnFD_t$	0.6022 (0.4424)	1.1863 (0.2828)	1.6122 (0.2117)	-------	0.0006 (0.9793)	0.8652 (0.3580)	-0.0009 [-0.4923]	0.4459 (0.6434)	1.0207 (0.3697)	0.8338 (0.4420)	------	0.1225 (0.8850)	0.5335 (0.5907)
ΔLnK_t	0.9402 (0.3382)	6.8437* (0.0126)	0.2297 (0.6344)	8.2180* (0.0067)	------	10.8186* (0.0021)	-0.3766* [-3.6979]	7.1236* (0.0023)	7.8570* (0.0014)	6.8792* (0.0028)	7.3646* (0.0019)	------	6.9590* (0.0026)
$\Delta LnURB_t$	9.6330* (0.0035)	1.1202 (0.2964)	0.8140 (0.3725)	1.2052 (0.2790)	4.3276** (0.0441)	------	0.0005 [0.3416]	4.9529* (0.0121)	0.8435 (0.4379)	0.5524 (0.5800)	1.2232 (0.3053)	2.1639 (0.1285)	------

Note: *,** represents the statistical significance level at 1% and at 5% respectively.
The value in the square brackets represents the T-Statistics for the error correction term. While the probability values have been shown in parenthesis. The lag criterion was utilised to select the optimal lag. Lag 1 was selected based on SIC. The Residual serial correlation LM test was performed and found the absence of serial correlation. The D.Vs correspond the dependent variables.

to capital with the electricity granger-cause urbanisation in the short-run. In trade model, a long-run bi-directional causality has been found between electricity consumption and capital. A short-run bidirectional causality has been found between urbanisation and electricity consumption and capital and urbanisation. While a uni-directional causality that runs from financial deepening to capital and electricity consumption. Another, uni directional causality that runs from capital formation to electricity consumption with economic growth granger-cause capital.

Table 5.12.VD for imports as an indicator of TO

VD of ln EK_t							
Period	S.E	ln EK_t	ln GDP_t	ln IMP_t	ln FD_t	ln K_t	ln URB_t
1	0.0746	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.1134	49.0660	4.5213	14.0395	13.2382	17.6814	1.4533
10	0.1211	46.4149	4.3969	15.8259	15.3254	16.6257	1.4110
15	0.1222	45.8165	4.5797	15.6781	15.9636	16.4001	1.5616
VD of ln GDP_t							
1	0.0233	0.4007	99.5992	0.0000	0.0000	0.0000	0.0000
5	0.0409	9.3884	40.5482	6.2859	14.2571	13.0627	16.4574
10	0.0456	8.8015	37.5599	7.5174	16.2858	14.1264	15.7087
15	0.0463	8.8369	37.1295	7.4387	16.6573	14.1028	15.8344
VD of ln IMP_t							
1	0.0735	0.0322	5.0600	94.9072	0.0000	0.0000	0.0000
5	0.0982	11.1028	4.7385	58.6659	15.3686	8.4939	1.6300
10	0.1040	10.6159	5.5498	55.8476	16.0623	9.6800	2.2441
15	0.1048	10.8190	5.5112	55.2029	16.1126	9.9563	2.3977
VD of ln FD_t							
1	0.4658	0.3696	0.5383	14.7006	84.3913	0.0000	0.0000
5	0.5656	5.8709	4.1932	11.5251	76.5569	0.6705	1.1831
10	0.5895	8.2238	4.2359	11.7077	71.1876	2.9238	1.7209
15	0.5923	8.1632	4.2965	11.7702	70.9240	3.1032	1.7426
VD of ln K_t							
1	0.1100	0.6651	14.2607	36.4779	8.0014	40.5946	0.0000
5	0.1716	5.5992	14.2714	25.3697	33.5760	18.6154	2.5680
10	0.1823 6	6.6456	14.8654	23.3710	33.5511	17.9733	3.5935
15	0.1842	6.6320	14.9561	22.9323	33.3000	18.0803	4.0989
VD of ln URB_t							
1	0.0001	5.4930	0.4021	6.2513	0.7581	25.5166	61.5785
5	0.0002	7.2297	1.2305	5.1274	0.7889	40.1349	45.4883
10	0.0002	7.6457	0.9267	4.0948	1.2289	41.0762	45.0274
15	0.0003	7.3386	0.9120	3.9419	1.1676	41.4264	45.2132

5.4. Variance Decomposition Results

The VECM model is more relevant and important from policy maker's perspectives. However, it is not possible to design specific policy measures because of some of the underlying potential drawback of VECM Granger causality. It is because of the inferences that it derives from the relative strength of causality with in the selected time period. However, additional inference based on the VECM causality test cannot be determined beyond the study sample period. In this connection, Shan (2005) argued in his study, the use of variance decomposition to solve this issue. Using this motivation, this study also applies variance decomposition for all three models to check the effects of shocks. The results for the variance decomposition has been presented in Table 5.12-5.14. Table 5.12 reveals the results of variance decomposition using import as an indicator for trade openness. The results of the variance decomposition analysis have been presented for 1, 5 10, and 15 periods respectively. The result shows that the 45.816% of the variations in electricity consumption has been largely accounted for itself. The rest of the variation in electricity consumption is explained by imports, financial deepening and capital that contribute 15.67%, 15.96%, and 16.04% respectively.

Table 5.13.VD for export as an indicator of TO

VD of ln EK_t							
Period	S.E	ln EK_t	ln GDP_t	ln EXP_t	ln FD_t	ln K_t	ln URB_t
1	0.0710	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.1119	46.3882	2.0177	19.8769	18.7116	11.1167	1.8887
10	0.1215	43.5646	3.2541	19.3052	20.5138	11.1157	2.2463
15	0.1229	42.8662	3.3840	19.3128	20.9382	11.0638	2.4347
VD of ln GDP_t							
1	0.0216	10.5323	89.4676	0.0000	0.0000	0.0000	0.0000
5	0.0420	8.1597	27.9126	9.7736	26.7578	10.7111	16.6849
10	0.0459	7.4282	26.9300	8.4551	29.8171	10.8408	16.5285
15	0.0470	7.7644	26.3680	8.4623	29.9213	10.5963	16.8874
VD of ln EXP_t							
1	0.0900	3.0860	8.5354	88.3785	0.0000	0.0000	0.0000
5	0.1092	5.0217	11.2609	66.0187	12.7209	0.9452	4.0324
10	0.1174	6.7992	10.3351	58.1821	16.8016	1.8372	6.0444
15	0.1190	6.7611	10.5485	57.1386	17.1689	2.0572	6.3254
VD of ln FD_t							
1	0.4412	0.7796	1.8069	16.2412	81.1712	0.0000	0.0000
5	0.5635	12.2099	2.8301	20.3720	61.3871	2.6769	0.5237
10	0.5842	14.5206	3.2064	20.3147	57.5172	3.1909	1.2500
15	0.5887	14.4780	3.2692	20.3255	57.3484	3.2729	1.3056
VD of ln K_t							
1	0.1097	2.8992	20.5663	19.8486	11.3904	45.2953	0.0000
5	0.1716	2.1598	14.2305	20.2503	34.2789	26.2205	2.8596
10	0.1820	3.6114	13.9506	19.6073	34.4591	23.8076	4.5637
15	0.1852	3.6539	14.0000	19.1604	34.9244	23.0482	5.2129
VD of ln URB_t							
1	9.8E-05	8.5511	0.0076	21.0933	0.3657	4.8710	65.1110
5	0.0002	5.8544	0.1989	24.9134	1.7308	9.3347	57.9674
10	0.0002	5.7720	0.5002	24.4878	1.2490	8.8843	59.1064
15	0.0003	5.8743	0.4817	23.3282	1.1237	8.9939	60.1979

Similarly, 37.12% of GDP has been explained by its own shock, while financial development capital and urbanisation contributes to the economic growth by 16.65%, 14.1028%, and 15.83% respectively in the long. Likewise in imports, 55.20% of its variations are explained in the long-run by its own innovative shock, while, 16.11% of variations is explained by the financial development. Also, in Table 5.13 15, 42.86% of the variations is largely accounted by itself while 19.3128%, 20.9382%, 11.0638% is contributed to electricity consumption by export, financial development and capital in long-run. Financial development and urbanisation contribute to the economic growth by 16.887% and 29.921% respectively in the long-run. While 26.368% of the variation in economic growth is largely accounted for itself in the long-run. Financial development explains export by 17.16%. However, exports contribute to financial development by 20.32%.

Table 5.14.VD for trade as an indicator of TO

VD of ln EK_t							
Period	S.E	ln EK_t	ln GDP_t	ln TR_t	ln FD_t	ln K_t	ln URB_t
1	0.0707	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.1095	46.3335	4.1149	15.6028	19.8331	12.7836	1.3319
10	0.1194	43.8727	4.9721	15.8857	21.5184	12.2605	1.4903
15	0.1205	43.4565	5.1232	15.8855	21.7455	12.1128	1.6762
VD of ln GDP_t							
1	0.0217	6.3099	93.6900	0.0000	0.0000	0.0000	0.0000
5	0.0409	8.5467	34.3960	14.4695	14.5734	10.9851	17.0291
10	0.0453	8.0285	33.7720	12.7641	18.1985	10.9517	16.2849
15	0.0465	8.3137	33.3233	12.2122	18.5520	11.1743	16.4241
VD of ln TR_t							
1	0.0588	5.3240	0.0009	94.6750	0.0000	0.0000	0.0000
5	0.0685	6.2833	3.6514	77.0752	3.8279	3.7343	5.4276
10	0.0764	8.5227	5.4758	65.6730	8.5497	5.4838	6.2946
15	0.0772	8.5665	5.5611	65.4167	8.4955	5.5291	6.4307
VD of ln FD_t							
1	0.4516	0.1727	3.5968	0.6271	95.6033	0.0000	0.0000
5	0.5614	7.9630	5.1756	6.5574	77.5255	1.7936	0.9846
10	0.5815	10.4313	5.3707	7.9174	72.2999	2.2503	1.7303
15	0.5857	10.3522	5.5318	8.0241	71.9157	2.4184	1.7574
VD of ln K_t							
1	0.1063	4.2517	21.9480	0.2096	25.6169	47.9735	0.0000
5	0.1718	4.6385	19.1944	12.7500	39.3035	21.6870	2.4263
10	0.1821	5.8771	19.4343	12.1639	38.0593	20.6165	3.8486
15	0.1847	5.9130	19.5599	12.1058	37.6669	20.2676	4.4866
VD of ln URB_t							
1	9.68E-05	3.3701	0.2338	3.4619	2.9425	17.9159	72.0755
5	0.0002	9.5001	0.2897	7.8418	2.0274	26.1453	54.1955
10	0.0003	10.5687	0.3133	9.8712	1.7255	25.6095	51.9116
15	0.0003	10.9910	0.2542	9.8628	1.4502	25.7839	51.6576

Similarly, 34.92% of variations and 19.16% of the variations in the capital are explained by financial development and export respectively. The role of financial development explains the major portion of the capital. Export adds into urbanisation by 23.32%.

Table 5.14 explains the variance decomposition results for trade as an indicator for trade openness. The results reveal that financial development, trade and capital explains 15.885%, 21.745% and 12.112% variations in electricity consumption respectively. Financial development and urbanisation contribute to economic growth by 18.55% and 16.425 respectively, while 33.323% of its variations comes from its own shock. Financial development contributes to capital by 37.66%, while 19.55% of variations is explained by economic growth in capital. Capital explains 25.78% of variations in urbanisation.

For import as an indicator of trade openness, our findings suggest the evidence of uni-directional causality from financial development to capital, import, and electricity consumption. While capital effects electricity consumption and economic growth is effected by capital. The overall results for export as an indicator of trade openness suggest the evidence of uni-directional long-run causality from capital to electricity consumption. Financial development granger-cause capital, while electricity causes urbanisation.

Finally, it has been noted, that the overall results for trade as an indicator of trade-openness suggest a uni-directional causality from financial development to electric consumption and capital Granger-cause electric consumption. Financial development and economic growth Granger cause capital, while a uni-directional causality has been found from capital to urbanisation. It was further noted that the results of the variance decomposition are robust to those obtained from VECM Granger causality. These findings further strengthen the reliability and robustness of our estimations.

5.5. NARDL Cointegration results

The results of the NARDL cointegration test as proposed by Shin et al. (2014) results for all three models using import, export and trade to measure the trade openness have been presented in Table 5.15-5.20 respectively.

The results suggest that in all three models (R^2 is above 0.90). This implies that the estimated variables in the model using import, export and trade openness explains 90%

Table 5.15.NARDL Cointegration results using Imports to measure the trade openness

	Coefficient	Standard error	T-Stat
Constant	9.4681	2.2021	4.30*
LEK(-1)	-1.0352	0.2181	-4.75*
LGDP_P(-1)	0.0156	1.3114	0.01
LGDP_N(-1)	1.9859	2.2788	0.87
LURB_P(-1)	7.6900	13.8022	0.56
LURB_N(-1)	0	0	0
LIMP_P(-1)	-1.2050	1.0568	-1.14
LIMP_N(-1)	0.4248	0.3425	1.24
LFD_P(-1)	-0.0680	0.0512	-1.33
LFD_N(-1)	0.0290	0.0900	0.32
LKP_P(-1)	1.6530	0.8632	1.91*
LKP_N	-0.6408	0.4362	-1.47
ΔLEK(-1)	0.5573	0.1797	3.10*
ΔLEK(-2)	-0.1972	0.1623	-1.21
ΔLEK(-3)	0.2026	0.1582	1.28
ΔLGDP_P	-1.1509	0.8532	-1.35
ΔLGDP_P(-1)	-0.1934	0.8430	-0.23
ΔLGDP_N	1.7555	1.4161	1.24
ΔLGDP_N(-1)	1.2703	1.1240	1.13
ΔLURB_P	157.7684	138.0232	1.14
ΔLURB_P(-1)	-272.4292	111.8751	-2.44*
ΔLURB_N	0	0	0
ΔLURB_N(-1)	0	0	0
ΔLIMP_P	-1.4856	0.6291	-2.36
ΔLIMP_P(-1)	0.0189	0.4867	0.04
ΔLIMP_N	0.0027	0.2923	0.01
ΔLIMP_N(-1)	0.1267	0.2811	0.45
ΔLFD_P	-0.1075	0.0493	-2.18
ΔLFD_P(-1)	-0.0089	0.0566	-0.16
ΔLFD_N	0.0595	0.1113	-0.54
ΔLFD_N(-1)	-0.0529	0.1153	-0.46
ΔLKP_P	0.7204	0.3900	1.85
ΔLKP_P(-1)	-0.2786	0.4110	-0.68
ΔLKP_N	0.1781	0.2053	0.87
ΔLKP_N(-1)	-0.211	0.2845	-0.74
Cointegration test statistics			
T_{BDM}	-4.7466*	F_{PSS}	8.3484*

Note: * represents the significance level at 1%. While p and n represent the positive and negative variations for the estimated variables respectively. FPSS represents the bounds test as proposed by Pesaran et al. (2001), while TBDM shows the Banerjee et al. (1998) statistics

of the change in the electricity consumption, while the rest of 10% variation is explained by the error term. All the three models are characterised by the absence of heteroscedasticity tests that were analysed using the Breusch/Pagan heteroskedasticity test. Likewise, the Jarque-Bera test confirms the normality of the residuals in all three model. Most importantly, it was noted that FPSS represents the bounds test as proposed by Pesaran et al. (2001), while TBDM shows the Banerjee et al. (1998) statistics that exceeds the upper bounds critical values even at 1% for all three models. This implies the evidence of asymmetric cointegration among the selected variables, and are moving together in a long-run relationship. This further confirms the robustness of the ARDL bounds test of cointegration that has been explained in the earlier sections. This further suggests the importance

Table 5.16.Long-run coefficients and Asymmetry tests using Imports to measure the trade openness

Long-run Coefficient:		Long-run effect [+]		Long-run effect [-]		
Exogenous Variable	Coefficient	F-Stat	P-value	Coefficient	F-Stat	P-value
lnGDP	0.015	0.0001	0.991	-1.918	0.8052	0.386
lnURB	7.428	0.3198	0.581	0.000	---	----
lnIMP	-1.164	1.993	0.181	-0.410	1.918	0.189
lnFD	-0.066	2.358	0.149	-0.028	0.1078	0.748
lnK	1.597	7.949	0.014	0.619	3.454	0.086
Asymmetry tests:		test Long-run asymmetry		Short-run asymmetry		
		W_{LR} F-Stat	P-value	W_{SR} F-Stat		P-value
lnGDP		0.3228	0.580	3.785		0.074
lnURB		0.3198	0.581	0.5403		0.475
lnIMP		2.479	0.139	2.579		0.132
lnFD		0.5749	0.462	0.3577		0.560
lnK		6.565	0.024	0.4617		0.509
Model Diagnostic test	Stat			P-value		
Breusch/Pagan heteroskedastcity test (Chi^2 value)	0.1498			0.6987		
Ramsey Reset test (F)	5.766			0.0149		
Jarque-Bera test on normality (Chi^2 value)	0.3255			0.8498		
R-squared	0.94					
Adjusted R-squared	0.81					
F-Statistics	7.38*					
Root mean square error	0.0434					

Note: * represents the significance level at 1%. The long-run effect positive and long-run affect negatively are the estimated long-run coefficients of the variables that are associated with negative and positive changes as identified in the previous table and can be defined as $\alpha^{+} = \frac{-\theta^{+}}{\partial}$ and $\alpha^{-} = \frac{-\theta^{-}}{\partial}$.

of taking asymmetry into the account when studying such relationships. It may also be noted here, that our previous estimation under the framework of an ARDL approach fails to measure the asymmetric relationship in both the short-run and long-run. However, the NARDL under unrestricted error correction mechanism determines both the short-run and long-run. As in Table 5.16 the long-run coefficients on lnK^{+} and lnK^{-} are1.597, 0.619 and statistically significant as well. This implies that if the capital formation rises by 1%, it will cause an increase in the demand for electricity consumption by 1.597%. But, if the capital decrease by 1%, it will cause a decrease in the electricity demand by 0.619%. This further implies that the rise in electricity demand is more. Also, the asymmetric tests from the above table further confirm that capital adjusts in the long-run asymmetric while GDP adjusts in the short-run asymmetric.

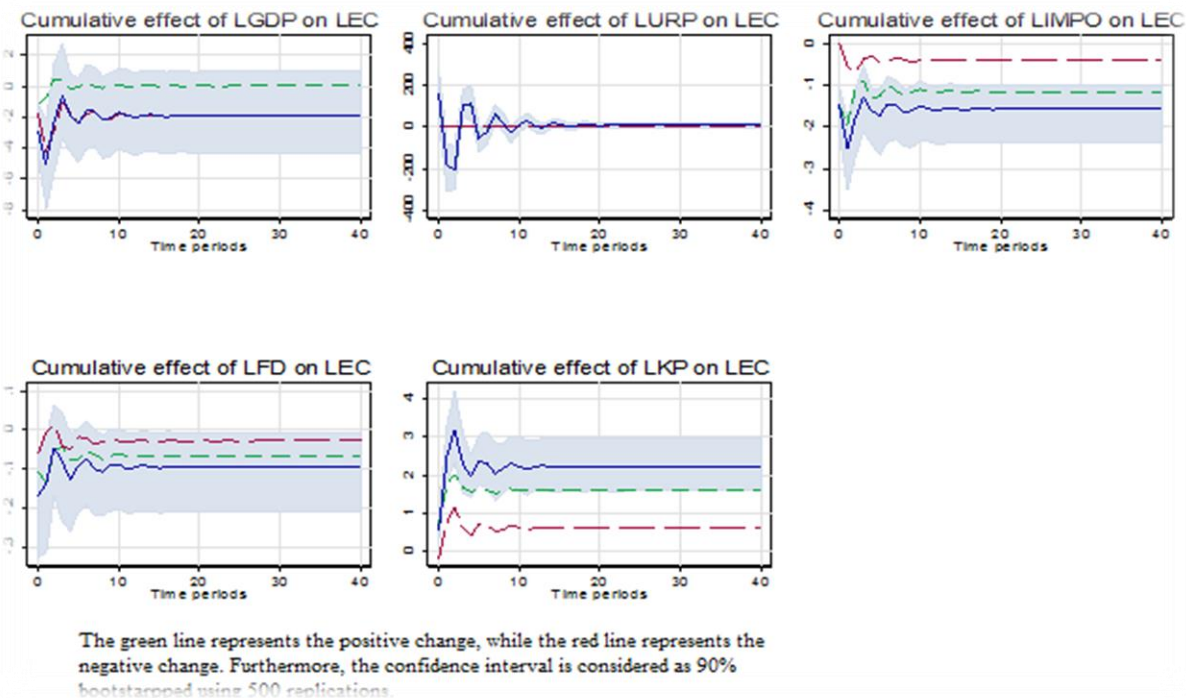


Figure 5.1.LEC, LGDP, LIMPO, LURP, LFD, LKP represents electricity consumption, real GDP per capita, imports per capita, urbanisation, financial development, and Gross fixed capital respectively.

The analysis of the dynamic effect of the explanatory variables including import on electricity consumption can further be explained by dynamic multiplies plots. The above figure shows the dynamic effect of positive and negative of the estimated variable including imports on electricity consumption. The findings confirmed a positive relationship between capital and economic growth in electricity consumption. Furthermore, the dynamic multiplier plot suggests the importance of asymmetry into the account among the estimated variables in the model.

Table 5.17.NARDL Cointegration results using export to measure the trade openness

	Coefficient	Standard error	T-Stat
Constant	13.0588	3.0584	4.27
LEK(-1)	-1.4767	0.2656	-5.56
LGDP_P(-1)	-0.8433	1.1247	-0.75
LGDP_N(-1)	5.4001	2.3765	2.27
LURB_P(-1)	7.1082	17.3619	0.41
LURB_N(-1)	0	0	0
LEXP_P(-1)	0.7065	0.5231	1.35
LEXP_N(-1)	-0.6264	0.6104	-1.03
LFD_P(-1)	-0.1009	0.0890	-1.13
LFD_N(-1)	-0.0576	0.1104	-0.52
LKP_P(-1)	1.4787	0.4572	3.23
LKP_N	-0.3563	0.3505	-1.02
ΔLEK(-1)	0.6130	0.1486	4.12
ΔLEK(-2)	0.1412	0.1520	0.93
ΔLEK(-3)	0.2477	0.1393	1.78
ΔLEK(-4)	0.2814	0.1251	2.25
ΔLGDP_P	-0.2750	0.6060	-0.45
ΔLGDP_P(-1)	0.3255	0.6287	0.615
ΔLGDP_N	3.0332	1.3896	2.18
ΔLGDP_N(-1)	-1.770	0.8459	-2.09
ΔLURB_P	-9.4968	146.7684	-0.06
ΔLURB_P(-1)	-131.8466	113.2596	-1.16
ΔLURB_N	0	0	0
ΔLURB_N(-1)	0	0	0
ΔLEXP_P	0.5613	0.2743	2.05
ΔLEXP_P(-1)	0.1619	0.2761	0.59
ΔLEXP_N	-0.1373	0.2913	-0.47
ΔLEXP_N(-1)	-0.1192	0.4574	-0.26
ΔLFD_P	-0.0584	0.5925	-0.99
ΔLFD_P(-1)	-0.0322	0.0481	-0.67
ΔLFD_N	0.0091	0.0903	0.10
ΔLFD_N(-1)	0.0915	0.1009	0.91
ΔLKP_P	0.0535	0.1716	0.31
ΔLKP_P(-1)	-0.8228	0.2890	-2.85
ΔLKP_N	0.0739	0.1869	0.40
ΔLKP_N(-1)	0.1578	0.1941	0.81
Cointegration test statistics			
T_{BDM}	-5.5589*	F_{PSS}	11.4716*
Note: * represents the significance level at 1%. While p and n represents the positive and negative variations for the estimated variables respectively. F_{PSS} represents the bounds test as proposed by Pesaran et al. (2001), while T_{BDM} shows the Banerjee et al. (1998) statistics.			

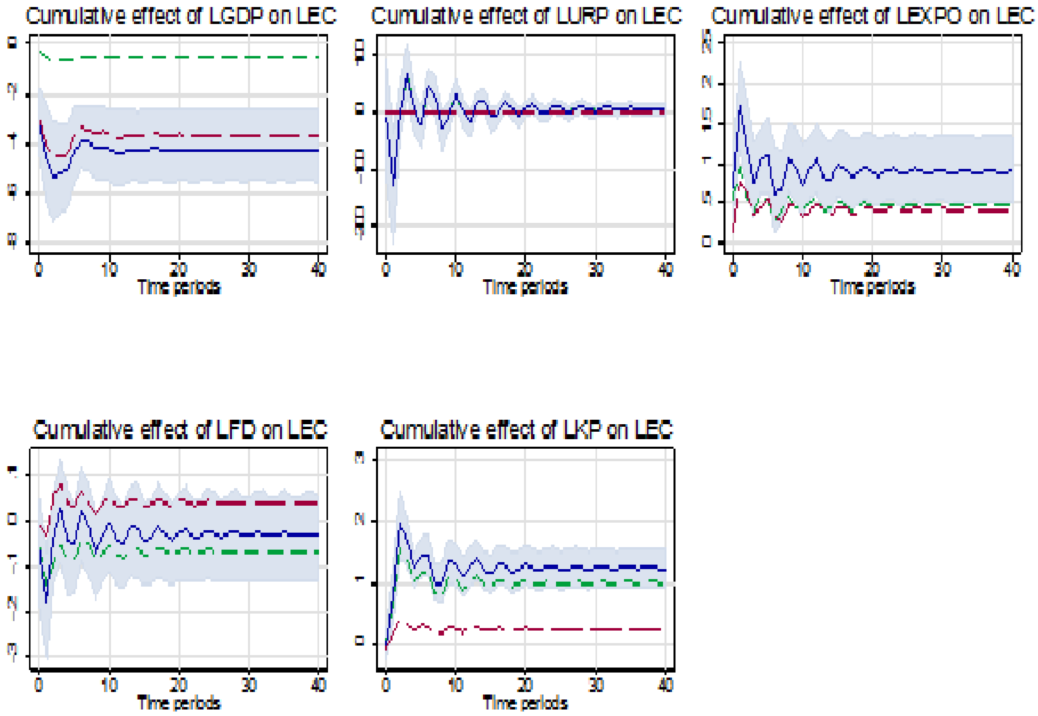
Table 5.18.Long-run coefficients and Asymmetry tests using export to measure the trade

Long-run Coefficient:		Long-run effect [+]		Long-run effect [-]		
Exogenous Variable	Coefficient	F-Stat	P-value	Coefficient	F-Stat	P-value
lnGDP	-0.571	0.5526	0.473	-3.6757	7.782	0.018
lnURB	4.813	0.1543	0.702	0.000	----	----
lnEXP	0.478	2.623	0.134	0.424	1.451	0.254
lnFD	-0.068	1.814	0.205	0.039	0.2497	0.627
lnK	1.001	30.91	0.000	0.241	1.237	0.290
Asymmetry tests:		test Long-run asymmetry		Short-run asymmetry		
		W_{LR} F-Stat	P-value	W_{SR} F-Stat		P-value
lnGDP		4.491	0.058	0.6519		0.437
lnURB		0.1543	0.702	0.4629		0.510
lnEXP		2.37	0.152	1.595		0.233
lnFD		0.0556	0.818	1.543		0.240
lnK		11.23	0.006	4.307		0.062
Model Diagnostic test		Stat		P-value		
Breusch/Pagan heteroskedastcity test (Chi^2 value)		0.0334		0.8548		
Ramsey Reset test (F)		6.548		0.0151		
Jarque-Bera test on normality (Chi^2 value)		1.778		0.4111		
R-squared		0.976				
Adjusted R-squared		0.906				
F-Statistics		13.96*				
Root mean square error		0.0304				

Note: * represents the significance level at 1%. The long-run effect positive and long-run effect negatively are the estimated long-run coefficients of the variables that are associated with the negative and positive changes as identified in the previous table and can be defined as $\alpha^{+} = \frac{-\theta^{+}}{\partial}$ and $\alpha^{-} = \frac{-\theta^{-}}{\partial}$.

Table 5.18 suggests that the long-run coefficients on $\ln K^{+}$ are positive and statistically significant as well. This implies that the by increasing the capital formation by one percent will increase the demand for electricity by 1.001%. While the long-run effect of $\ln GDP^{-}$ is -3.6757. This suggests that if the GDP rises by one percent. It will cause the electricity demand to decrease by 3.6757%. Moreover, the effect of GDP^{+} is also negative but it's statistically insignificant. These finding obtained from the NARDL are robust with the standard ARDL model. Also both, the capital and GDP adjust asymmetrically in both the short-run and long-run.

The dynamic multiplier in an export model of NARDL suggests, that GDP, export, and capital have a positive and asymmetric effect on electricity consumption. These findings are also in line with those obtained from NARDL model.



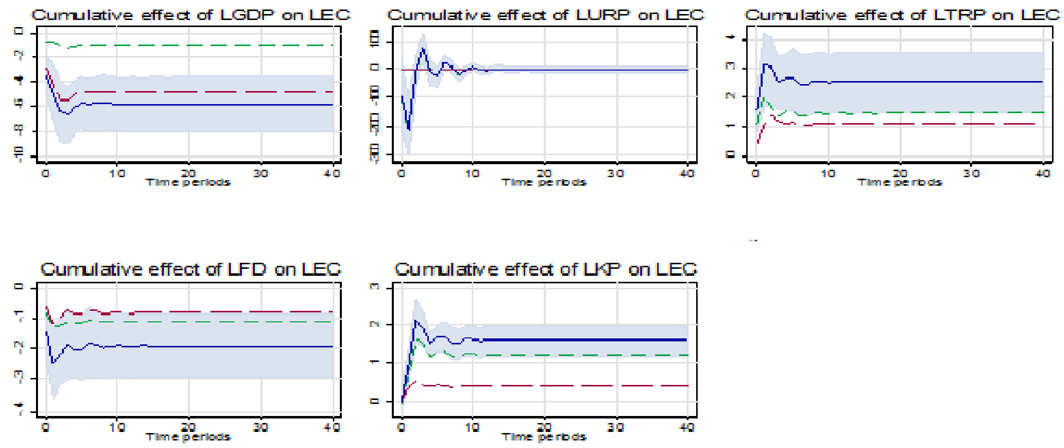
The green line represents the positive change while the red line represents the negative changes. Furthermore the confidence interval is consdiered as 90% bootstrapped values using 500 replications.

Figure 5.2.LEC, LGDP, LEXPO, LURP,LFD, LKP represents electricity consumption, real GDP per capita, exports per capita, urbanisation, financial development, and Gross fixed capital respectively.

Table 5.19 shows the results of trade as a measure of trade openness. The results suggest that the long-run coefficients on $\ln TR^{+}$ and $\ln K^{+}$ are 1.424 and 1.224 and positive and significant. This implies that if the trade and capital rise by 1%, then the demand in the electricity consumption will rise by 1.424 and 1.224% respectively. However, FD effects electricity usage negatively. The results of the dynamic multiplier for all the estimated variables are similar to those obtained from import and export model.

Table 5.19.Long-run coefficients and Asymmetry tests using trade to measure the trade openness

	Coefficient	Standard error	T-Stat
Constant	11.7098	1.5495	7.56*
LEK(-1)	1.1921	0.1568	-7.60*
LGDP_P(-1)	-1.1773	1.0842	-1.09
LGDP_N(-1)	5.7868	2.1656	2.67*
LURB_P(-1)	-3.1273	13.7947	-0.23
LURB_N(-1)	0	0	0
LTR_P(-1)	1.6973	0.7442	2.28*
LTR_N(-1)	-1.3321	0.7096	-1.88*
LFD_P(-1)	-0.1329	0.0551	-2.41*
LFD_N(-1)	0.0971	0.0892	1.09
LKP_P(-1)	1.4593	0.3435	4.25*
LKP_N	-0.4410	0.2623	-1.68**
ΔLEK(-1)	0.4165	0.1260	3.31*
ΔLEK(-2)	-0.0412	0.1845	-0.22
ΔLEK(-3)	0.1198	0.1044	1.15
ΔLEK(-4)	0.0660	0.1455	0.45
ΔLGDP_P	-0.7521	0.7083	-1.06
ΔLGDP_P(-1)	0.5995	0.6529	0.92
ΔLGDP_N	2.8453	1.2648	2.25*
ΔLGDP_N(-1)	-2.1925	0.9380	-2.34*
ΔLURB_P	-94.7883	144.7699	-0.65
ΔLURB_P(-1)	-185.7052	107.6135	-1.73*
ΔLURB_N	0	0	0
ΔLURB_N(-1)	0	0	0
ΔLTR_P	1.1249	0.5215	2.16*
ΔLTR_P(-1)	0.0821	0.3625	0.23
ΔLTR_N	-0.4492	0.4048	-1.11
ΔLTR_N(-1)	0.3333	0.3606	0.92
ΔLFD_P	-0.0838	0.0491	-1.71*
ΔLFD_P(-1)	0.0211	0.0508	0.42
ΔLFD_N	0.0626	0.0747	0.84
ΔLFD_N(-1)	0.0090	0.0905	0.10
ΔLKP_P	-0.0465	0.1887	-0.25
ΔLKP_P(-1)	-0.7952	0.2692	-2.95*
ΔLKP_N	-0.0241	0.1709	-0.14
ΔLKP_N(-1)	0.1008	0.1965	0.51
Cointegration test statistics			
T_{BDM}	-7.6017*	F_{PSS}	10.1938*



The gree line represents the positive change, while the red line line represents the negative change. Furthermore, the confidence interval is considered as 90% bootstrapped values using 500 replications.

Figure 5.3.LEC, LGDP, LTRP, LURP, LFD, and LKP represents electricity consumption, real GDP per capita, trade per capita, urbanisation, financial development per capita, and Gross fixed capital per capita respectively

Table 5.20.Long-run coefficients and Asymmetry tests using trade to measure the trade openness

Long-run Coefficient:		Long-run effect [+]		Long-run effect [-]		
Exogenous Variable	Coefficient	F-Stat	P-value	Coefficient	F-Stat	P-value
lnGDP	-0.988	1.151	0.306	-4.854	7.088	0.022
lnURB	-2.623	0.0507	0.826	0.000		
lnTR	1.424	4.542	0.056	1.117	3.202	0.101
lnFD	-0.112	5.355	0.041	-0.081	1.125	0.312
lnK	1.224	17.72	0.001	0.370	3.057	0.108
Asymmetry tests:		Long-run asymmetry		Short-run asymmetry		
		W_{LR} F-Stat	P-value	W_{SR} F-Stat		P-value
lnGDP		4.738	0.052	0.2833		0.605
lnURB		0.0507	0.826	2.334		0.155
lnTR		4.137	0.067	1.751		0.213
lnFD		2.533	0.140	0.8699		0.371
lnK		12.03	0.005	3.016		0.110
Model Diagnostic test		Stat		P-value		
Breusch/Pagan heteroskedastcity test (Chi^2 value)		0.1516		0.6971		
Ramsey Reset test (F)		5.891		0.0201		
Jarque-Bera test on normality (Chi^2 value)		0.1601		0.1601		
R-squared		0.973				
Adjusted R-squared		0.895				
F-Statistics		12.46*				
Root mean square error		0.0322				

Note: * represents the significance level at 1%. The long-run effect positive and long-run effect negatively are the estimated long-run coefficients of the variables that are associated with the negative and positive changes as identified in the previous table and can be defined as $\alpha^+ = \frac{-\theta^+}{\partial}$ and $\alpha^- = \frac{-\theta^-}{\partial}$.

5.6: Asymmetric Causalities between Electricity Consumption, Financial Development Index, Import, Export, Trade, Urbanisation And Economic Growth

Table 5.21.Asymmetric and non-Asymmetric (Symmetric) causal Results

Causality models	W-Test	VAR order	CV at 1%	CV at 5%	CV at 10%
$EK \rightarrow GDP$ *(1)*	8.206**	1	12.089	7.111	5.250
$EK^{+} \neq GDP^{+}$ *(2)*	3.269	1	10.529	5.046	3.409
$EK^{-} \rightarrow GDP^{-}$ *(3)*	8.652**	1	14.388	7.465	5.293
$GDP \neq EK$ *(4)*	5.048	1	11.417	7.003	5.171
$GDP^{+} \neq EK^{+}$ *(5)*	0.054	1	7.802	3.979	2.782
$GDP^{-} \rightarrow EK^{-}$ *(6)*	12.001*	1	11.608	7.127	5.224
$EK \rightarrow FD$ *(7)*	96.943*	1	20.422	11.013	8.055
$EK^{+} \rightarrow FD^{+}$ *(8)*	16.834*	1	11.890	6.926	5.173
$EK^{-} \rightarrow FD^{-}$ *(9)*	52.351*	1	25.170	11.290	7.687
$FD \neq EK$ *(10)*	5.617	1	13.408	8.598	6.681
$FD^{+} \rightarrow EK^{+}$ *(11)*	6.021***	1	11.287	6.807	5.026
$FD^{-} \neq EK^{-}$ *(12)*	3.389	1	16.083	9.943	7.231
$EK \neq TR$ *(13)*	0.185	1	8.537	4.196	2.804
$EK^{+} \rightarrow TR^{+}$ *(14)*	2.832***	1	8.052	4.148	2.808
$EK^{-} \neq TR^{-}$ *(15)*	1.864	1	10.457	4.466	2.919
$TR \neq EK$ *(16)*	0.204	1	7.963	4.156	2.833
$TR^{+} \neq EK^{+}$ *(17)*	2.823	1	10.875	4.825	2.948
$TR^{-} \neq EK^{-}$ *(18)*	1.292	1	9.236	4.249	2.837
$EK \neq K$ *(19)*	0.010	1	8.034	4.221	2.955
$EK^{+} \neq K^{+}$ *(20)*	2.706	1	8.195	4.123	2.760
$EK^{-} \neq K^{-}$ *(21)*	4.480	1	13.607	7.418	5.189
$K \rightarrow EK$ *(22)*	3.860***	1	8.348	4.473	3.013
$K^{+} \rightarrow EK^{+}$ *(23)*	11.275*	1	9.425	4.178	2.828
$K^{-} \rightarrow EK^{-}$ *(24)*	21.597*	1	13.811	7.339	5.173
$EK \neq URB$ *(25)*	0.066	1	13.619	7.932	5.587
$EK^{+} \neq URB^{+}$ *(26)*	0.000	1	7.666	4.281	2.976
$EK^{-} \neq URB^{-}$ *(27)*	0.079	1	6.688	3.951	2.761
$URB \neq EK$ *(28)*	0.167	1	17.458	8.631	6.104
$URB^{+} \neq EK^{+}$ *(29)*	1.442	1	7.301	4.065	2.847
$URB^{-} \neq EK^{-}$ *(30)*	0.056	1	6.483	3.829	2.759
$EK \neq IMP$ *(31)*	0.336	1	8.025	4.169	2.874
$EK^{+} \rightarrow IMP^{+}$ *(32)*	3.137***	1	8.523	4.343	2.886
$EK^{-} \neq IMP^{-}$ *(33)*	2.421	1	10.838	4.868	2.975
$IMP \neq EK$ *(34)*	0.317	1	7.389	4.121	2.827
$IMP^{+} \neq EK^{+}$ *(35)*	0.220	1	7.541	4.024	2.733
$IMP^{-} \neq EK^{-}$ *(36)*	0.028	1	10.359	4.687	3.039
$EK \neq EXP$ *(37)*	0.052	1	9.805	4.344	2.808
$EK^{+} \neq EXP^{+}$ *(38)*	0.324	1	8.143	4.127	2.789
$EK^{-} \neq EXP^{-}$ *(39)*	0.194	1	11.178	4.567	2.826
$EXP \neq EK$ *(40)*	0.766	1	8.423	4.046	2.719
$EXP^{+} \rightarrow EK^{+}$ *(41)*	9.422*	1	8.764	4.333	2.873
$EXP^{-} \rightarrow EK^{-}$ *(42)*	19.520*	1	8.922	4.892	3.430

Note: The numbers in the parenthesis have been highlighted to refer them in the interpretation of results. $\neq$ and $\rightarrow$ represent no causal relationship and unidirectional. Critical values are represented by CV, that have been obtained by using 10000 simulations to compute the bootstrapped critical values. Furthermore, Hatemi-J Criterion (HJC) is utilised to select the optimal lag. The maximum order of integration (d_{max}) I (1) was determined using the ADF, PP and KPSS unit root test. The extra lag was augmented as proposed by Toda and Yamamoto (1995) in the unrestricted VAR. *, **,*** represents significance level of the computed test statistics at 1%, 5%, and 10% respectively.

Hatemi-J (2012) in his study proposed non-asymmetric and asymmetric causality that was applied in the study. The results of the asymmetric and symmetric causality test are reported in Table 5.21. The results revealed the presence of symmetric causality between electricity consumption and economic growth is uni-directional (line 1), running from electricity consumption to economic growth. These findings of our study are in concordance with the studies of Wolde-Rufael (2010)[8] and Paul and Bhattacharya (2004) for top 38 countries. However, by analysing the asymmetric results, these findings are true only for the negative shocks in electricity consumption (line 3). Previous studies have not reported these findings as the asymmetric causality test has not been applied. These findings of our study are in line with the recent study conducted by Shahbaz et al. (2017) for India. To the best of our knowledge, this is the only study that has investigated the asymmetric effect. However, some of the previous studies of Shahbaz et al. (2016) and Mandal and Madheswaran (2012) partly support the finding of our study. This finding implies that the energy conservation policies are recommended that can impede economic growth thus would decrease the aggregate demand for the electricity consumption (negative shock is EC that runs in a uni-direction to the negative shocks in GDP as showed in line 3). These findings of our study highlight the significance of the asymmetric causal relationship amongst electricity use and GDP that cannot be ignored in crafting the energy policies for Iceland. Similarly, by analysing the asymmetric results, we noted an asymmetric causality of the negative shocks to GDP, line 6. This outcome suggests that decreasing the economic growth can cause a decrease in electricity consumption, which will deteriorate the economic situation in Iceland. Furthermore, it is also suggested to utilise the energy resources efficiently by following the economy of scale. The symmetric causal relationship between electricity consumption and financial development is significant (line 7). This result suggests that electricity plays an important role in improving the financial development of Iceland. These findings of our studies are in contradiction with Faisal et al. (2017) who reported the neutral relationship between energy consumption and financial development for Pakistan. However, the asymmetric causality between electricity consumption and financial development suggests that if positive and negative shock in electricity consumption will cause increase or decrease in financial development line 8 and line 9. This further

8 Wolde-Rufael (2010) in his study utilized nuclear energy use as a proxy to analyse the energy consumption for India.

implies that electricity plays a vital role in strengthing the financial sector. For an efficient financial system in Iceland, the availability of electricity must be ensured to achieve the financial targets. If appropriate management of electricity is not ensured, then ultimately this would hamper financial development. The positive shocks of financial development to the positive shock of electricity consumption shows an asymmetric causal relationship that is significant (line 11). This implies that both financial development and electricity consumption play a vital role in the development of economy by achieving a sustainable growth in the long-run if properly managed. This further suggests that improvement in financial development will cause an upsurge in the electricity demand. The addition of financial deepening in the demand function for electricity will help and assist the policy makers in Iceland to maintain the level of electricity in order to obtain better environmental quality. This result of asymmetric causality highlights the importance of financial development into the electricity demand function. However, these findings of our study are in contradiction with Shahbaz et al. (2017) for India who reported no significant causal relationship between EC and financial development. The asymmetric causal relationship between the positive shock of electricity consumption and trade is significant (line 14). This implies that increasing electricity consumption will have a favourable impact on trade. This further highlight the importance of the trade variable as the important determinant of the electricity demand function. The policy makers in Iceland is suggested to design efficient trade policy by considering the role of electricity consumption. We noted a symmetric and asymmetric causal relationship as well between positive shocks of capital and electricity consumption (line 22 and line 23). These findings imply the significance of fixed capital formation in overcoming the demand for the electricity consumption. This further suggests that the fiscal policy may be designed to increase the capital will have a significant impact on electricity and this will promote economic growth. Also, the significant asymmetric causal relationship of the negative shock of capital to the negative shock of electricity consumption is revealed (line 24). This results highlight that if the fiscal policy designed to decrease the capital formation will cause a decrease in the electricity consumption and thus will hamper economic growth. We also noted the asymmetric causal relationship between the positive shocks of electricity consumption to the positive shock of imports (line 32). This suggests that electricity demand must be ensured in order to use the imported big-ticket consumer items. These finding also supports the study of (Sadorsky, 2010; Chang, 2015) who argued that big ticket consumer normally requires more electricity on an individual basis that can affect the country's aggregate demand for electricity/ energy use. Finally, an asymmetric causality of positive and negative shock in exports will cause positive and negative shocks in electricity consumption (line 41, 42). These findings imply that the electricity use by industries can increase the production and hence more exports can be done that can upsurge the demand for electricity. However, lowering the exports can cause the domestic production lower that demands less electricity consumption. Moreover, this lowering of exports will have a negative effect on the economy by producing a low output.

CHAPTER SIX

6. Electricity Consumption and Economic Growth: Emperical Evidence from Iceland

6.1 Introduction

Electricity is one of the most important sectors and plays a major role in the economic development of many countries. It is a multifaceted sector that supports the development of a wide range of products and services, playing an active role in improving living standards, increasing the productivity and efficiency as well as encouraging investors and entrepreneurial activities. The electricity sector has a close relationship with real GDP per capita and, on the basis of the above-mentioned facts, both the real per capita GDP and electricity consumption are highly correlated, which has been extensively documented by Ferguson et al. (2000) in a study covering approximately 100 countries. Iceland has a significant manufacturing sector, making the consumption of electricity in that country one of the highest compared with the rest of the world. The source of electricity production in Iceland is predominantly from hydroelectric and geothermal energy.

The most important aspect of this issue is the investigation and gathering of sufficient knowledge on the causality direction between GDP and electricity consumption (EC) with a view to devising appropriate policies for future energy and energy conservation measures. The central theme of the debate revolves around whether electricity consumption promotes or retards economic growth. The utilisation of modern energy in the production process, along with capital and labour, is considered as a prerequisite for social, economic and technological progress (see Dunkerley, 1982, Ebohon, 1996, Templet, 1999). The researchers, who are in support of the above-mentioned hypothesis, confirmed that, without energy, economic growth and technological progress will be unachievable. The importance of modern energy, particularly electricity cannot be ignored, as it has been a significant factor in the improvement of people’s living standards, as well as the scientific and technological developments of even developed countries (Rosenberg, 1998). In developing countries, in particular, the use of electricity has significantly improved the health and education standards of the population (IEA, 2002). In the modern era, the utilisation of electricity cannot be ignored in terms of the development of the economy and infrastructure. Furthermore, the literature on energy suggests a reliable and effective infrastructure is one of the most important criteria for sustained growth and diversification. In the recent literature, it has been demonstrated that the improvement of infrastructure has resulted in an increase in urbanisation, witnessed by the rapid increase in the development of urban areas. Over the past four decades, the urban population in Iceland has been abruptly rising. Since 1965, the urbanisation in Iceland has risen from 82.7% to 93.94% by the year 2014, with an average annual growth rate of 0.229%. Liu et al. (2013) argued in his study that a rapid increase in population in urban areas has a favourable and positive impact on economic growth. However, on the other hand, the increase in the urban population is increasing energy consumption, thus creating an energy crisis (Al-Mulali, U., 2012).

Various studies have elucidated the relationship between electricity consumption, economic growth and urbanisation. However, to the author's knowledge, no study in the literature exists that has analysed the electricity demand function for Iceland, together with urbanisation and trade. Thus far, Khraief et al. (2016) estimated the electricity demand function using urbanisation and trade in their study on Algeria. The relationship between EC and GDP together with trade and urbanisation will be analysed in the present. Therefore, this study tries to cover the gap in the literature.

The present study contributes to the literature in four different ways. First, up-to-date data has been acquired from the World Bank (2017) based on the availability. Secondly, the bounds test for cointegration is employed to examine the presence of cointegration in order to estimate the long-run relationship in the electricity demand function for Iceland. Thirdly, the long-run and short-run elasticities are investigated under the ARDL framework, using trade and urbanisation together in an electricity demand function. Fourthly, the causal relationship among the estimated variables is investigated using the VECM Granger causality test. Suitable recommendations based on empirical results will be crafted that will aid the Government of Iceland in adopting efficient energy policies.

6.2 Literature review

There are many studies available in the literature that have been conducted in recent decades on the topic of GDP and EC from both empirical and theoretical perspectives. The studies were conducted with the aim of ascertaining the causality direction of energy consumption and economic growth. Three specific views have been inferred from the empirical studies conducted. One view is that, as the economy expands, the increase in energy consumption rises due to demand. The following view confers that the economy expands because of the upsurge in energy usage. However, the third view is that both economic growth and energy consumption affect each other simultaneously, i.e. there is a bi-directional causality. In these studies, not only was the causal relationship examined, but also the long-term relationship was determined between energy consumption and economic growth. This is evident from the studies conducted by Ewing et al. (2007), Ozturk (2010), and Lee (2006) who established four different hypotheses. The growth hypothesis (unidirectional), states that the EC plays an important role in improving economic conditions and the direction of causality runs from energy consumption to economic growth; this indicates that economic growth will cease if there is a severe energy crisis, hence, energy conservation measures may not be a feasible option. However, in the conservation hypothesis, it is the economic growth that causes the increased consumption of energy, supported by a causality that moves from GDP to EC. This suggests that, even if there is an energy crisis, the economic growth will not stop, thus implying that an energy conservation measure is a feasible option. The feedback hypothesis, implying that the growth causes the energy or the energy causes the growth, is supported by the mutual relationship between EC and GDP, reinforced by its bi-directional causality. In the neutrality hypothesis, neither the energy consumption nor the GDP effects each other. Recent studies on the above-mentioned issue include papers by Acaravci and Ozturk (2010), and Ozturk and Acaravci (2011). The GDP and EC per capita variables were studied to investigate the causal relationship between 15 selected transition countries by Acaravci and Ozturk (2010) using Pedroni Panel cointegration for the period 1990 to 2006. The authors' estimations confirmed the absence of any relationship between EC and GDP. In a similar study by Ozturk and Acaravci (2011), used the ARDL bounds testing approach was used to examine the relationship between GDP and EC from 1990-2006 for 11 MENA countries. The authors reported the absence of any long-run relationship between EC and GDP in Syria, Morocco and Iraq. The estimations further showed a unidirectional causality in the short run from GDP to EC for Israel. However, a unidirectional causality was found in Saudi Arabia, Oman, Egypt in both the long run and short run, as well as from electricity consumption to GDP. The author concluded that the results indicate confirmation of a weak long-run causal relationship between EC and GDP. Table 6.1 shows a summary of the literature review on electricity and energy consumption.

Table 6.1.Literature Review

Authors	Country	Sample	Methodology	Causality direction	Hypothesis
Soyatas and Sari (2003)	Italy, Japan, South Korea	1950-1992	Vector error correction model, Granger Causality test	GDP — EC	Neutrality hypothesis
Akinlo (2008)	Ghana, Gambia and Senegal	1980-2003	Fully modified OLS	GDP ↔ EC	Feedback hypothesis
Twerefo et al. (2008)	Ghana	1975-2006	VEC model, Granger causality	GDP → EC	Conservation Hypothesis
Fatai et al. (2004)	Philippines	1960-1999	Toda and Yamamoto	GDP ↔ EC	Feedback hypothesis
Stern (2000)	U.S.A	1948-1994	Cointegration, Granger causality	EC → GDP	Growth hypothesis
Halicioglu (2007)	Turkey	1968-2005	ARDL, Granger causality	GDP → EC	Conservation Hypothesis
Odhiambo (2009a)	Tanzania	1971-2006	ARDL Bounds test	EC → GDP	Growth hypothesis
Odhiambo (2009b)	South Africa	1971-2006	ARDL Bounds test	GDP → EC	Conservation Hypothesis
Shiu and Lam (2004)	China	1971-2000	Cointegration and VECM	GDP → EC	Conservation Hypothesis
Narayan and Smyth (2005)	Australia	1966-1999	Multivariate Granger causality	GDP → EC	Conservation Hypothesis
Faisal et al. (2016)	Russia	1990-2011	Toda and Yamamoto	EK ↔ GDP	Feedback hypothesis
Faisal et al.(2017)	Pakistan	1971-2013	ARDL, VECM	GDP → EC	Conservation Hypothesis

However, in the current scenario, the studies pertaining to EC and GDP have been extended by using urbanisation. The empirical results from many different studies conducted in different countries are varied. Many studies identified that GDP, urbanisation, and EC are correlated. Parshall et al. (2010) reported a positive relationship among EC and urbanisation for the case of the USA. Likewise, similar findings were reported by Salim and Shafiei (2014), who investigated this relationship for OECD countries. Lenzen et al. (2006) conducted a study using panel data for different countries, which included Denmark, Japan, Australia, and Brazil, by analysing the influence of urbanisation on EC. The findings of the study indicated that the influence of urbanisation on GDP differs, even during the same time period. A similar study was conducted by Liddle (2013) and found a strong association between urbanisation and GDP. However, the study further suggested that urbanisation is the driver of economic growth, and its impact varies across regions (countries), depending on their level of income and development. In their recent study, Liddle and Messinis (2015) further identified that the association between urbanisation and GDP shows an increased correlation in high-income and low-income countries. In another study, Liddle and Lung (2014) utilized panel data and the causality direction moves from EC to urbanisation. Kasman and Duman (2015) conducted a study for European Union member countries using panel data. Their findings suggested evidence of a one-way causality from urbanisation to GDP and GDP to EC. However, the study conducted by Poumanyvong Kaneko (2010) identified that urbanisation causes a decrease in the energy consumption in the low-income group, while the reverse causality occurs for middle and high-income groups. Likewise, Shahbaz et al. (2012) confirmed a long-run causal relationship between urbanisation and energy consumption for Tunisia. The same results were confirmed by Shahbaz et al. (2014) for the United Arab Emirates. The above-mentioned studies predominantly explained the connection between EC, urbanisation and GDP. However, there are also some studies in the literature that have further extended this model by including foreign direct investment and trade. For example, the study conducted by Acaravci et al. (2015) investigated the production function using the ARDL bounds test to investigate the relationship between EC and GDP in the presence of foreign direct investment and trade. Their study findings indicated that electricity consumption and FDI effects GDP positively, while trade affects GDP negatively. The results of the Granger causality test in their studies suggested that electricity consumption Granger causes economic growth.

Marques et al. (2016), in his study on Greece, analysed the relationship between electricity consumption and industrial production for the period between 2004 and 2014 using monthly data. Their findings suggested that the electricity generated from fossil sources plays a major role in promoting industrialisation and hence causes economic growth. In another study on France, Marques et al. (2016), applied the ARDL bounds test to analyse the relationship between the electricity generation mix and economic growth. The findings of the study confirmed a long-run relationship among the estimated variables. Furthermore, electricity that is generated from nuclear energy has a positive impact on economic growth, with less Co_2 emissions.

In a similar respect, there are many studies in the literature that have interlinked electricity consumption demand with urbanisation and economic growth, which are considered as important determinants for various other economies. To the extent of the author's knowledge, no study has been conducted for Iceland that specifies electricity demand as a function of urbanisation, economic growth and trade for Iceland and explores an empirical relationship that is supported by well-developed methods that are reliable. There is a deficit in the literature linking and analysing a relationship among these variables, which provides the motivation to estimate an electricity consumption demand model that is suitable for Iceland in order to determine an effective energy policy.

6.3 Methodology of the study

6.3.1 Data

The multivariate framework includes the electric power in kWh per capita and real GDP per capita (in constant 2010 US$); urbanisation is measured by total urban population and trade openness as a percentage of GDP. The data series is from the period 1965-2013 and was collected from the World Bank 2017 database. The data has been collected for a period of 49 years, which is sufficient to apply the ARDL technique on the time series.

6.3.2 Model specification and econometric methodology

This study investigates the relationship between electricity consumption and economic growth by incorporating trade and urbanisation in the electricity demand function. In their study, Lin and Liu (2016) argued that increases in electricity consumption have been predominantly caused by the population increases in urban areas, the establishment of new industries, commercial usage, new construction and the household sector. The sudden growth in urbanisation and trade openness has attracted the attention of researchers to ICT development, industrial activities, trade, improvements to the infrastructure in urban areas and financial development. Cerdeira Bento and Moutinho (2016) in their study, argued that these indicators not only encourage domestic economic activities at a local level but also cause an upsurge in the volume of exports and imports. On the basis of the above-mentioned discussion, an empirical model was identified by Khraief et al. (2016), which includes trade and urbanisation, and can be written as:

$$EK_t = \beta_0 + \beta_1 GDP_t + \beta_2 TR_t + \beta_3 URB_t + \varepsilon_t \quad (6.1)$$

Where EK_t represents electric power consumption (kWh per capita), GDP_t represents real GDP per capita (constant 2010 US$), TR_t is the sum of real exports and imports, URB_t represents the urban population and ε_t is the error term that should be white noise. All the variables highlighted in Equation 6.1 are transformed in the natural logarithms to lessen the effect of heteroscedasticity, if it exists. All the series have been converted to per capita by dividing it using population series. The logarithmic form[9] of the mentioned model can be written as:

$$\ln EK_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln TR_t + \beta_3 \ln URB_t + \varepsilon_t \quad (6.2)$$

Where β_0 is the constant term and β_i (where i=1, 2, 3) are the long-run elasticities with respect to GDP, trade and urbanization. Equation 6.2 is examined to check for a possible long-run relationship among $\ln EK_t$ the natural log of electricity per capita Kwt per capita,$\ln GD\,P_t$ (natural log of real GDP per capita), $\ln TR_t$ natural log of trade per capita, which is equal to the imports as a percentage of GDP and exports as a percentage of GDP/total population, $\ln URB_t$ and the natural log of urbanization which is equal to urban population/total population. The expected sign forβ_1, β_2 and β_3 must be positive, as documented in the literature.

6.4 Model stability and diagnostic tests:

The evidence of a long-run relationship among the estimated variables using Equation 6.2 does not necessarily imply the stability of the estimated coefficients over the sample period (Bahmani-Oskooee & Chomsisengphet, 2002). In order to investigate the reliability and validity of the ARDL model, several diagnostic tests are applied along with the stability tests. In this connection, the diagnostic tests are used to identify the presence of heteroscedasticity, the residual serial correlation, and the correlogram

[9] The logarithmic transformation helps to eliminate the variations in the time series data. Without logarithmic transformation, the results may be inappropriate and unreliable.

of residuals to ensure that they are white noise. The stability of the model can be checked by using the CUSUM test, as proposed by Brown et al. (1975).

Once the long-run relationship among the estimated variables has been confirmed using Equation 6.2, this study further employs the Granger causality test to investigate the direction of causality among the estimated variables. If there is evidence of cointegration among the estimated variables, as identified in Equation 6.2, then the error correction model can be developed using Equation 6 as below.

$$\begin{bmatrix} \Delta\ln \mathrm{EK} \\ \Delta\ln \mathrm{GDP} \\ \Delta\ln \mathrm{URB} \\ \Delta\ln TR \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \begin{bmatrix} S_{11,1} & S_{12,1} & S_{13,1} & S_{14,1} \\ S_{21,1} & S_{22,1} & S_{23,1} & S_{24,1} \\ S_{31,1} & S_{32,1} & S_{33,1} & S_{34,1} \\ S_{41,1} & S_{42,1} & S_{43,1} & S_{44,1} \end{bmatrix} \times \begin{bmatrix} \Delta\ln \mathrm{EK}_{t-1} \\ \Delta\ln \mathrm{GDP}_{t-1} \\ \Delta\ln \mathrm{URB}_{t-1} \\ \Delta\ln TR_{t-1} \end{bmatrix} + \ldots +$$

$$\begin{bmatrix} S_{11,m} & S_{12,m} & S_{13,m} & S_{14,m} \\ S_{21,m} & S_{22,m} & S_{23,m} & S_{24,m} \\ S_{31,m} & S_{32,m} & S_{33,m} & S_{34,m} \\ S_{41,m} & S_{42,m} & S_{43,m} & S_{44,m} \end{bmatrix} \times \begin{bmatrix} \Delta\ln \mathrm{EK}_{t-m} \\ \Delta\ln \mathrm{GDP}_{t-m} \\ \Delta\ln \mathrm{URB}_{t-m} \\ \Delta\ln TR_{t-m} \end{bmatrix} + \begin{bmatrix} \phi_1 \\ \phi_2 \\ \phi_3 \\ \phi 4 \end{bmatrix} \times (ECT_{t-1}) + \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \\ \eta_{4t} \end{bmatrix}$$

(6.3)

Where "Δ" represents the first difference operator, while ECT_{t-1} represents the lagged error correction term. The value of the ECT must be between 0 and 1 with a negative sign that represents the convergence of the dynamics back to the equilibrium following a short-run shock. The existence of the long-run relationship between the variables in the model using Equation 6.2 necessarily implies the presence of a causal relationship, among the estimated variables, which is either unidirectional or bidirectional (Johansen & Juselius 1990; Engle & Granger 1987). The error correction term of the VECM model identifies the evidence of a long-run relationship. Furthermore, the *F*-statistics (Wald test) along with the corresponding *P*-values are used to compute the short-run or weak Granger causality. Furthermore, Asafu-Adjaye (2000) in their study proposed a joint test of both the short-run and long-run by suggesting that following a short-run shock, the variables in the system reorganize themselves to re-establish a long-run relationship among the estimated variables. Lee and Chang (2008) identified it as a strong Granger causality test that can be performed by testing the relevant coefficients of the first difference series along with the relevant coefficients of the lagged error correction term.

6.5 Empirical Results and Analysis

6.5.1 Unit Root Test for Stationarity

The ARDL model can be applied to any series that have a mixed order of integration. However, it must be ensured that none of the variables is *I* (2). For this reason, the Augmented Dickey Fuller test proposed by Dickey and Fuller (1979), the Philips-Perron (PP) test by Philips and Perron (1988) and the KPSS from Kwiatkowski et al. (1992) are applied to analyse the integration order of the series. The unit root tests are performed both at the level and the first difference with intercept and with intercept and trend. The results of the unit root tests have been shown in Tables 6.2, 6.3 and 6.4 respectively.

Table 6.2.ADF Unit root test

	Level		1st Difference		Dec.
	CO	CO & TR	CO	CO & TR	
$LnEK_t$	-1.8565 (1)	-3.0805 (1)	-4.7622*** (0)	-4.8481*** (0)	*I*(1)
$LnGDP_t$	-1.0269 (1)	-2.2065 (1)	-4.5138*** (0)	-4.4877*** (0)	*I*(1)
$LnTR_t$	-1.7927 (0)	-1.1630 (0)	-5.6247*** (0)	-5.6356*** (0)	*I*(1)
$LnURB_t$	-81.9530*** (0)	-18.7763***(0)	-3.4668** (0)	-2.2693 (4)	*I*(0)

Note: (i) The ADF tests have been utilized using the intercept and both the trend and intercept first with level and then with the first difference. The figures in the parenthesis represent the lag that was selected using the Schwarz information criteria (SIC). *, **, *** represents significance at 1%, 5%, and 10%. Where CO and CO & TR represents intercept, and intercept and trend. Where ADF stands for Augmented Dickey Fuller Unit Root test.

Table 6.3.PP Unit root test

	Level		1st Difference		
	CO	CO & TR	CO	CO & TR	Dec.
$LnEK_t$	-1.5144 (1)	-2.1953 (1)	-4.7947*** (1)	-4.8481*** (0)	*I*(1)
$LnGDP_t$	-1.4552 (2)	-1.7041 (1)	-4.5567*** (3)	-4.4107*** (4)	*I*(1)
$LnTR_t$	-1.8102 (7)	-1.0294 (8)	-5.5890*** (14)	-5.7641*** (20)	*I*(1)
$LnURB_t$	-56.8794*** (3)	-13.0768*** (3)	-6.6168*** (11)	-1.3084 (5)	*I*(0)

Note: The PP tests have been utilized using the intercept and both the trend and intercept first with level and then with the first difference with Newey-West using Bartlett Kernel. The figures in the parenthesis represent the lag that was selected using the Schwarz information criteria (SIC). *, **, *** represents significance at 1%, 5%, and 10%. Where CO and CO & TR represents intercept, and intercept and trend. Where PP stands for Philips Perron (PP) Unit Root test

Table 6.4.KPSS Unit root test

	KPSS				Dec.
	Level		1st diff		
	CO	CO & TR	CO	CO & TR	
$LnEK_t$	0.8716*** (5)	0.4864*** (0)	0.2351 (0)	0.1100 (1)	*I*(1)
$LnGDP_t$	0.8692*** (5)	0.3312*** (1)	0.1710 (1)	0.0158 (1)	*I*(1)
$LnTR_t$	0.9388*** (2)	0.2836*** (2)	0.2081 (2)	0.0508 (2)	*I*(1)
$LnURB_t$	0.7903** (5)	0.3323** (3)	0.8816*** (5)	0.2268*** (5)	*I*(0)

Note: The KPSS tests have been applied first using the intercept and both the trend and intercept with level and then with the first difference with the Spectral estimation method selected is Bartlett Kernel while, the Newey-West method is used to select the bandwidth. The figures in the parenthesis represent the bandwidth. *, **, *** represents significance at 1%, 5%, and 10%. Where CO and CO & TR represents intercept, and intercept and trend. Where KPSS represents Kwiatkowski-Philips-Schmidt-Shin Unit Root test.

Tables 6.2-6.4 show a summary of the ADF, PP and KPSS unit roots, respectively. It was found that electricity consumption, economic growth and trade are non-stationary at the level, but become stationary by taking the first difference. However, urbanisation is stationary at the level, which is confirmed by all the unit root tests. As the variables have a mixed order of cointegration, the traditional cointegration tests, including the Johansen and Juselius (1990), are not applicable, and therefore cannot be employed. All the regressors of the current study have been found *I*(1) except urbanisation, which is *I*(0). However, as the electricity consumption (EK_t) is the dependent variable and is integrated of order *I*(1), and none of the variables in the series is *I*(2), this fulfils the conditions necessary for the ARDL approach to be used.

Therefore, it is possible to proceed with the bounds test or F-test to determine the long-run relationship between the variables, as proposed by Pesaran et al. (2001). The results of the bounds test of cointegration are shown in Table 6.5.

Table 6.5.Results of the Bounds test of Co-integration

Estimated Model	F_{LEK}(LnEK/LnGDP,LnTR,LnURB)			
OPL length (AIC)	(4,0,0,0)			
F-Stat. (Bound Test)[10]	8.9126*			
CV	1%	2.5%	5%	10%
LBCV	4.29	3.69	3.23	2.72
UBCV	5.61	4.89	4.35	3.77

Note: * represents significance level at 1%. The optimal lag is selected using AIC information criteria. Pesaran et al., 2001 critical values have been used to compare with the F-Statistics value. Where OPL,

[10] The above ARDL model is computed using case III (with unrestricted intercept and no trend)

CV, LBCV and UBCV optimal lag length, critical values, upper bounds critical values, lower bounds critical values.

The optimum lag length, which was selected on the basis of the AIC criterion is demonstrated in the second row. The ARDL computed *F*-statistics is analysed to verify the existence of cointegration. The critical values from Pesaran et al. (2001) have been shown in Table 6.5 to determine the existence of cointegration. The computed F-statistics (8.91) exceeds the upper bounds critical values. This highlights strong evidence of cointegration among the estimated variables. Additionally, it implies that the estimated variables in the model are in a long-run association in the Icelandic economy. The result further confirms that electricity usage, trade openness, GDP and urbanisation move together in the long run. The long-run elasticity and short-run elasticity is computed using Equations 6.4 and 6.5 under the ARDL framework. The long-run results are classified in panel A, while the short-run results are placed in panel B.

Table 6.6.ARDL Long-run and short-run results

Dependent Variable: Ln EK_t	**(Panel A) Long-run results**		
Variable	Coefficient	S.E	t-Stat.
Ln GDP	1.4120	0.3865	3.6524*
Ln TR	1.1373	0.2487	4.5733*
Ln URB	9.0231	3.8375	2.3512*
R^2	0.987	F-statistics	430.7932*
Adj. R^2	0.985	D.W	2.21
(Panel B) Short-run results			
Variable	Coefficient	S.E	t-Stat.
ΔLn EK(-1)	0.2986	0.1130	2.6410*
ΔLn EK(-2)	-0.0195	0.1214	-0.1611
ΔLn EK(-3)	0.2821	0.1152	2.4478*
ΔLn GDP	0.6443	0.2228	2.8916*
ΔLn TR	0.5190	0.1226	4.2321*
ΔLnURB	4.1177	1.9035	2.1631*
Constant	2.4906	0.3942	6.3167*
ECM_{t-1}	-0.4563	0.0735	-6.2081*
R^2	0.558	S.E of regre.	0.0708
Adj. R^2	0.514	Sum Sq. reside	0.2010
F-Stat.	12.6603*	D.W	2.21

Note: * represents significance level at 1% respectively.

Table 6.6 shows both the long-run and short-run coefficients, whereas electricity consumption is taken as the dependent variable. The long-run elasticity of economic growth with respect to electricity consumption is elastic, positive and statistically significant. This indicates a positive and significant impact of economic growth on electricity consumption. This also implies that a 1% rise in economic growth leads electricity usage by 1.41% by keeping other factors constant. These empirical findings are in concordance with the studies by Zhao et al. (2015) for China, Khraief et al. (2016), Narayan et al. (2009), Odhiambo (2009) and Solarin and Shahbaz (2013). This suggests that more economic growth has been achieved with more electricity consumption over time. The elasticity of trade with respect to economic growth is positive and statistically significant as well. It was found that a 1% increase in trade will cause the electricity consumption to increase by 1.13% if all other factors are constant. This further implies that trade (imports and exports) causes an upsurge in electricity demand. This rise in demand for electricity is large because of the import of “big ticket” items like washing machines, and refrigerators. To the best of the author’s knowledge, few studies have analysed the trade activities and electricity consumption relationship utilizing time series data Keho et al. (2016), Rafindadi & Ozturk (2015), Lin and Liu (2016), Lin et al. (2016). These outcomes based on this empirical study are in concordance with previous studies, such as those by Keho et al. (2016), Rafindadi and Ozturk (2016) and Bento and Moutinho (2016); indicating the positive and causal impact of trade openness (imports and exports) on electricity consumption.

The elasticity of urbanisation with respect to EK is elastic, positive and statistically significant at 1%. This indicates that a 1% increase in urbanisation would lead to the demand for electricity increasing by 9.02%. The results of this study are in line with the previous studies of Gam and Ben Rejeb (2012), Solarin and Shahbaz (2013), Liddle and Lung (2014), Zhao and Wang (2015), Acaravci and Ozturk (2010) and Rafindadi and Ozturk (2016). The positive impact in the case of Iceland is not surprising as the population of Iceland has been gradually increasing with 97% of the population currently living in urban areas, which has consequently increased the consumption of electricity.

The results of the short-run model are also shown in Table 6.6, Panel-B. In the short run, the signs for the estimated variables are the same as in the long run. This implies that economic growth, trade, and urbanization have a positive and statistically significant impact on economic growth, not only in the long run but also in the short run. The error correction term is -0.4563 with the expected sign and it is statistically significant, even at 1%. This demonstrates the speed of adjustment of the electricity demand function from the short run towards its long-run equilibrium path. The short-run variations are adjusted by 45.63% within the first year. This convergence from the short run to the long run would take approximately 2 years and 2 months. The ability of the system to converge back to its equilibrium position implies the system has stability.

The diagnostic tests for these estimations have been conducted not only for the long run but also for the short run. The results of the diagnostics tests have been demonstrated for both the long run and short-run in Table 6.7 and Table 6.8, respectively. The diagnostic tests indicate that the estimations have no problems of serial correlation and the residuals are homoscedastic. The residuals of the Q-statistics were checked at all lags and the absence of serial correlation was found, which verifies the assumption of the classical linear regression model. Furthermore, the stability of both the short-run and long-run model was tested by using the cumulative (CUSUM) and cumulative sum of squares (CUSUMsq), as suggested by Brown et al. (1975). The plots of both the CUSUM and CUSUMsq lie between the two-bonded lines at 5% significant level. This confirms the stability of the long-run and short-run coefficients for the selected period in the present study.

Table 6.7. Diagnostic Tests (Long run)

Diagnostic Test	χ^2_{SC}	χ^2_{w}	χ^2_{AR}
Iceland	3.8073 (0.1490)	37.0159 (0.1185)	0.2149 (0.6430)

NOTE: χ^2_{serco}, χ^2_{whi} and χ^2_{ARh} for serial correlation, White test for heteroscedasticity, Arch tests for heteroscedasticity. The figures in the parenthesis show the corresponding P-values.

Table 6.8.Diagnostic Tests (Short run)

Diagnostic Test	χ^2_{SC}	χ^2_{w}	χ^2_{AR}
Iceland	2.4649 (0.2916)	41.5427 (0.1462)	0.0709 (0.7899)

NOTE: χ^2_{serco}, χ^2_{whi} and χ^2_{ARh} are the Lagrange multiplier value for serial correlation, White test for heteroscedasticity, Arch tests for heteroscedasticity. The figures in the parenthesis show the corresponding P-values.

The diagnostic test further strengthens the reliability of the findings and estimations.

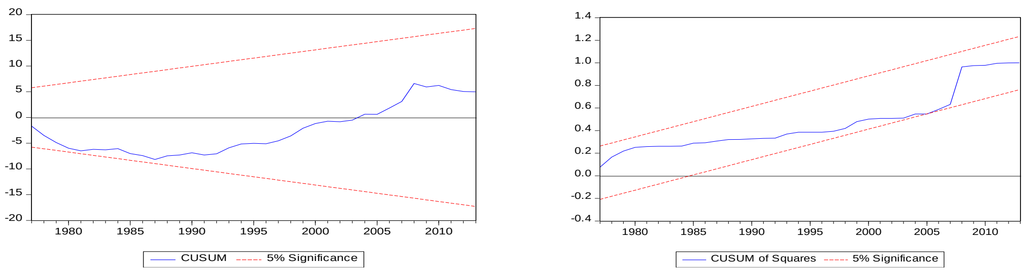


Figure 6.1.Stability tests using CUSUM. The blue line lies between the two red lines at 5% significance level, implying the stability of both long-run and short-run coefficients.

6.6 Granger Causality results

The current study investigated the causal relationship among urbanization, trade, electricity consumption and economic growth within the VECM framework. The VECM is applied to the cointegrated series. The results of the short-run, long-run and Joint (Short-run and long-run) causality have been shown in Table 6.9.

Table 6.9.Results of Granger Causality Tests

Dependent Variable	*F*-Statistics (Probability) long-run					Joint (Short- and long-run) *F*-Statistics (Probability)			
	Δ ln EK_{t-1}	Δ ln GDP_{t-1}	Δ ln TR_{t-1}	Δ ln URB_{t-1}	ECT_{t-1} [*t*-stat]	Δ ln EK $.ECT_{t-1}$	Δ ln GDP. ECT_{t-1}	Δ lnTR $.ECT_{t-1}$	Δ ln URB $.ECT_{t-1}$
Δ ln EK	----	0.9611 (0.3921)	0.9798 (0.3852)	4.6705* (0.0157)	-0.2981* [-3.1396]	----	3.5623* (0.0235)	4.4026* (0.0097)	5.0813* (0.0049)
Δ ln GDP	1.0242 (0.3693)	----	0.8128 (0.4516)	1.4271 (0.2532)	-0.1524 [-1.3528]	1.1478 (0.3430)	----	1.1209 (0.3534)	1.5534 (0.2175)
Δ ln TR	0.8679 (0.4284)	4.6470* (0.0160)	-----	3.2135** (0.0520)	0.1269*** [1.7393]	1.2119 (0.3193)	3.1840* (0.0353)	----	2.1626 (0.1094)
Δ ln URB	1.1443 (0.3297)	0.2215 (0.8023	1.5130 (0.2339)	-----	-0.0138* [-2.3828]	3.5695* (0.0233)	2.0165 (0.1289)	3.5247* (0.0245)	----

Note: *, ** and *** showed the significance level at 1%, 5% and 10% respectively. The figure in the above table represent the corresponding P-values and the T-statistics are shown in the square brackets. The lag length was chosen 2 based on AIC, FPE, HQ, LR lag criteria.

The short-run results of the present study imply the existence of a unidirectional causality from urbanization to electricity consumption. This implies that increasing population in the urban areas would cause an upsurge in aggregate demand for electricity consumption. The import of big ticket consumer items further requires more electricity consumption, thus affecting Iceland's electricity demand. Also, urbanization and economic growth are causing trade, thus validating the growth-led trade hypothesis in the short run for Iceland, which is in concordance with the findings reported by Shahbaz (2012) for Pakistan. This suggests that both urbanization and economic growth stimulate trade. This further highlights the importance of the trade variable in the econometric model. Moreover, no short-run or long-run causalities from either direction have been found between economic growth and electricity consumption, thus validating the neutrality hypothesis. However, as can be observed, the coefficient of ECT_{t-1} (-0.2981 and –0.0138) are negative and statistically significant at 10% in the electricity usage equation and urbanization equation. These outcomes from this study are also in line with the studies by Sbia et al. (2017). This further infers the evidence of a long-run bi-directional causality between electricity usage and urbanization in Iceland, which validates the feedback hypothesis. This indicates that the increasing rate of the urban population in Iceland may contribute to enhance trade and output given the skilled labour as a factor of production. This would lead to further development of the Icelandic economy due to improvements in its infrastructure, including to transport, the electricity network and better housing to maximize the efficiency of the economy by satisfying the urban population.

CHAPTER SEVEN

7 Conclusion and Policy Implications

Chapter 5 investigates the role of urbanisation, financial deepening, economic growth, capital and trade by considering the time series data from 1965-2013. This thesis applied the Perron and Vogelsang (1992) that accounts for one endogenous structural break to determine the order of integration in addition to the conventional unit root tests. The ARDL bounds test of cointegration is applied to analyse the cointegration among the estimated variables. The results of cointegration confirm the evidence of a long-run relationship. Furthermore, the long-run and short-run elasticity are determined under the framework of an ARDL approach. The findings confirmed that trade, capital, financial deepening, urbanisation has a positive and significant impact on electricity demand in the long-run. Furthermore, the squared term of financial Deeping is investigated to analyse its impact on electricity consumption. An inverted U-shaped relationship between financial Deeping and electricity consumption but insignificant in the export model in long-run. This suggests that financial Deeping has little or no role in delinking of electricity consumption and financial development at the higher level of financial system development. However, an existence of a significant inverted U-shaped relationship between financial Deeping and electricity consumption in import and trade openness model in the short-run. The negative sign of the non-linear implies the delinking of electricity consumption and financial development at the much improved level of financial development. Furthermore, the VECM model under the ARDL framework along with variance decomposition to investigate the direction of causality. Using import as an indicator of trade openness, the thesis findings suggest the evidence of uni-directional causality from financial development to capital, import, and electricity consumption. While capital effects electricity consumption and economic growth. This implies that the banks can advance loans that will enable the firms and household to purchase the utility and big ticket items. Furthermore, the import of household items would also require electricity to use. As explained in the previous section, the Iceland is having a rich reservoir of electricity generated from hydropower and geothermal that enables the local consumer to use the electricity with the cheapest price among all the OECD countries. Financial deeping also causes the capital to generate thus mobile it in the productive channels will provide more return to the firm and house hold. Likewise, for export as an indicator of trade, openness suggests the evidence of uni-directional long-run causality from the capital to electricity consumption. Financial development granger-cause capital as imports, while electricity causes urbanisation. This implies that more arrival of the general public and opening of new business in the urban areas would cause the consumption of electricity higher. For trade as an indicator of trade openness, a uni-directional causality from financial development to electric consumption and capital granger-cause electric consumption was found. Financial development and economic growth Granger cause capital, while a uni-directional causality has been found from capital to urbanisation. This suggests that capital is considered as an important while evaluating the trade as a proxy that can measure the trade openness. The results of the variance decomposition are robust to those obtained from VECM Granger causality test.

The NARDL also confirms the evidence of cointegration among the estimated variables. Finally, the Hatemi-J (2012) causality test is applied to investigate the asymmetric and the symmetric causal relationship among the variables. Their finding suggests based on results that the energy conservation policies are recommended that can impede economic growth thus would decrease the aggregate demand for the electricity consumption. Fiscal policy may be designed to upsurge the gross capital formation will have a significant impact on electricity and this will promote economic growth. The study further suggested that electricity plays a vital role in strengthing the financial sector. For an efficient financial system in Iceland, the availability of electricity must be ensured at lower prices to achieve the financial targets. If appropriate management of electricity is not ensured, then ultimately this would hamper financial development. Finally, by increasing electricity consumption to various industries will have a favourable impact on trade

Chapter six investigated the nexus between electricity consumption and economic growth, including trade and urbanisation for Iceland, by using time series data from 1965 to 2013. The ARDL bounds approach was employed to investigate the long-run relationship between the estimated variables. Strong evidence of cointegration was found among trade, electricity consumption, economic growth and urbanisation for Iceland. The economic growth, trade and urbanisation have a positive impact on electricity consumption not only in the long-run but also in the short-run. Furthermore, urbanisation appears to be the driver of electricity consumption.

Moreover, the results of the Granger causality confirm the existence of a short-run unidirectional causality from urbanization to electricity consumption. This implies that more inward movement of the urban population would cause increase consumption of electricity. Additionally, evidence of a long-run bidirectional causality has been found between electricity consumption and urbanization in Iceland, which confirms the feedback hypothesis. This infers that the Government of Iceland should continue to invest more in the generation of electricity to sustain the developments in urbanization by using renewable energy. The evidence of a feedback hypothesis between urbanisation and electricity consumption further confirms that both urbanisation and electricity consumption are important elements for the development of the Icelandic economy. However, no causal relationship between economic growth and electricity consumption for both the long-run and short-run have been found from either direction, which validates the neutrality hypothesis. This infers that any changes in the economic growth of Iceland will not have a substantial effect on electricity usage. These findings are of more importance to the policymakers, as implementing the energy conservation policy in this regard will have no damaging effect on economic growth for Iceland.

The empirical results of this study provide a contribution to the literature and sufficient information to policy makers to achieve a better understanding of the economic growth, electricity and consumption nexus in the context of urbanisation as well as to formulate energy policies in Iceland. Additionally, the government of Iceland should encourage and invest more funds in research and development to support technological innovation that could increase energy savings. By doing so, the environmental degradation may be simultaneously decreased by increasing the economic development in the Icelandic economy. Moreover, the government should consider the economic stages (situations) while formulating and implementing energy policies.

REFERENCES

Abouie-Mehrizi, M., Atashi, S. M., & Elahi, M. (2012). The effect of variables population growth, urbanization and economic growth on CO2 Emissions in Iran. African *Journal of Business Management, 6*, 8414–8419.

Acaravc, A., Erdogan, S., & Akal, G. (2015). The electricity consumption, real income, trade openness and FDI: the empirical evidence from Turkey. *International Journal of Energy Economics and Policy*, *5*(4).

Acaravci, A., & Ozturk, I. (2010). Electricity consumption-growth nexus: evidence from panel data for transition countries. *Energy Economics*, *32*(3), 604-608.

Acaravci, A., & Ozturk, I. (2012). Electricity consumption and economic growth nexus: A multivariate analysis for Turkey. *Amfiteatru Economic*, *14*, 246–257.

Adebola, S. S., & Opeyemi, B. M. (2011). Multivariate causality test on electricity consumption, capital, labour and economic growth for Nigeria. *Journal of Business & Economics*, *3*(1), 1.

Akinlo, A. E. (2008). Energy consumption and economic growth: evidence from 11 Sub-Sahara African countries. *Energy economics*, *30*(5), 2391-2400.

Akpan, G. E., & Akpan, U. F. (2012). Electricity consumption, carbon emissions and economic growth in Nigeria. *International Journal of Energy Economics and Policy*, 2, 292–306.

Al-Mulali, U. (2012). Factors affecting CO_2 emission in the Middle East: a panel data analysis. *Energy*, *44*(1), 564-569.

Al-Mulali, U., & Ozturk, I. (2015). The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. *Energy*, *84*, 382-389.

Ang, J. B., & McKibbin, W. J. (2007). Financial liberalization, financial sector development and growth: evidence from Malaysia. *Journal of development economics*, *84*(1), 215-233.

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy economics*, *22*(6), 615-625.

Bahmani-Oskooee, M., Chomsisengphet, S., (2002). Stability of M2 demand functions in industrial countries. *Applied Economics* 34, 2075–2083.

Bayer, C., & Hanck, C. (2013). Combining non-cointegration tests. *Journal of Time Series Analysis*, *34*(1), 83-95.

Bélaïd, F., & Abderrahmani, F. (2013). Electricity consumption and economic growth in Algeria: A multivariate causality analysis in the presence of structural change. *Energy Policy*, *55*, 286-295.

Bento, J. P. C., & Moutinho, V. (2016). CO 2 emissions, non-renewable and renewable electricity production, economic growth, and international trade in Italy. *Renewable and Sustainable Energy Reviews*, *55*, 142-155.

Bhattacharya, M., Paramati, S.R., Ozturk, I., Bhattacharya, S., (2016). The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. *Applied Energy 162,* 733-741.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B (Methodological)*, *149*-192.

Chang, S. C. (2015). Effects of financial developments and income on energy consumption. International Review of Economics & Finance, 35, 28-44.

D. Dickey and W. A. Fuller.,(1981) "Likelihood ratio statistics for autoregressive time series with a unit root," *Econometrica, vol. 49*, pp. 1057-72.

Dan, Y., & Lijun, Z. (2009). Financial development and energy consumption: an empirical research based on Guangdong Province. Paper presented at International Conference on Information Management, Innovation Management and Industrial Engineering, 2009, ICIII, 3, 102-105.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Dogan, E. (2015). The relationship between economic growth and electricity consumption from renewable and non-renewable sources: A study of Turkey. Renewable and Sustainable Energy Reviews, 52, 534-546.

Duan, J., Yan, Y., Zheng, B., & Zhao, J. (2008). Analysis of the relationship between urbanization and energy consumption in China. *International Journal of Sustainable Development & World Ecology, 15,* 309–317.

Dunkerley, J. (1982). Estimation of energy demand: the developing countries. *The Energy Journal*, *3*(2), 79-99.

Ebohon, O. J. (1996). Energy, economic growth and causality in developing countries: a case study of Tanzania and Nigeria. *Energy policy*, *24*(5), 447-453.

Enders, W. (1995). Applied Econometric Time Series. New York: John Wiley & Sons Inc.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Ewing, B. T., Sari, R., & Soytas, U. (2007). Disaggregate energy consumption and industrial output in the United States. *Energy Policy*, *35*(2), 1274-1281.

FAISAL, F., TÜRSOY, T., & REŞATOĞLU, N. G. (2017). Is there any Causality between Financial Development, Energy Consumption and Economic Growth in Pakistan? Evidence from ARDL Bounds Testing Approach and Vector Error Correction Model. *International Journal of Ecological Economics and Statistics™*, *38*(2), 33-48.

Faisal, Tursoy, T., & Resatoglu, N. G. (2016). Energy Consumption, Electricity, and GDP Causality; the Case of Russia, 1990-2011. *Procedia Economics and Finance*, *39*, 653-659.

Fatai, K., Oxley, L., & Scrimgeour, F. G. (2004). Modelling the causal relationship between energy consumption and GDP in New Zealand, Australia, India, Indonesia, The Philippines and Thailand. *Mathematics and Computers in Simulation*, *64*(3), 431-445.

Ferguson, R., Wilkinson, W., & Hill, R. (2000). Electricity use and economic development. *Energy policy*, *28*(13), 923-934.

Gam, I., & Rejeb, J. B. (2012). How can we assess the relation between equipment, price and electricity demand in Tunisia? *International Journal of Energy Economics and Policy*, *2*(3), 159.

Gupta, G., & Chandra, S. N. (2009). Causality between electricity consumption and economic growth: Empirical evidence from India. http://mpra.ub.unimuenchen.de/22942

Halicioglu, F. (2007). Residential electricity demand dynamics in Turkey. *Energy economics*, *29*(2), 199-210.

Hatemi-J, A., 2003. A new method to choose optimal lag order in stable and unstable VAR models.*Applied Economics Letters* 10, 135–137.

Hatemi-J, A. (2012a). Is the UAE stock market integrated with the USA stock market? New evidence from asymmetric causality testing. *Research in International Business and Finance, 26*, 273–280.

Hatemi-J, A. (2012b). Asymmetric causality tests with an application. *Empirical Economics*, *43*, 447–456.

Hu, J. L., & Lin, C. H. (2008). Disaggregated energy consumption and GDP in Taiwan: A Threshold co-integration analysis. *Energy Economics, 30*, 2342–2358.

IEA (International Energy Agency), 2002. Energy and poverty. In: World Energy Outlook, 2002. IEA, Paris.

Islam, F., Shahbaz, M., & Alam, M. (2013). Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis. *Economic Modelling*, *30*, 435–441.

Jalil, A., & Feridun, M. (2011). Impact of financial development on economic growth: empirical evidence from Pakistan. *Journal of the Asia Pacific Economy*, *16*(1), 71-80.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and statistics*, *52*(2), 169-210.

Jones, D. (1991). How urbanization affects energy-use in developing countries. *Energy Policy, 19,* 621–630.

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.

Kasman, A., & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. *Economic Modelling*, *44*, 97-103.

Keho, Y. (2016). What drives energy consumption in developing countries? The experience of selected African countries. *Energy Policy*, *91*, 233-246.

Khan, M. A., & Qayyum, A. (2007). Trade, financial and growth nexus in Pakistan (No. 2007, 14). Economic analysis working papers.

Khraief, N., Shahbaz, M., Mallick, H., & Loganathan, N. (2016). Estimation of electricity demand function for Algeria: Revisit of time series analysis. *Renewable and Sustainable Energy Reviews*.

Mahalik, M. K., Babu, M. S., Loganathan, N., & Shahbaz, M. (2017). Does financial development intensify energy consumption in Saudi Arabia? *Renewable and Sustainable Energy Reviews*, *75*, 1022-1034.

Kwiatkowski, D., Phillips, P. C., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of econometrics*, *54*(1-3), 159-178.

Lee, C. C. (2006). The causality relationship between energy consumption and GDP in G-11 countries revisited. *Energy Policy*, *34*(9), 1086-1093.

Lee, C. C., & Chang, C. P. (2008). Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data. *Resource and energy Economics*, *30*(1), 50-65.

Lenzen, M., Wier, M., Cohen, C., Hayami, H., Pachauri, S., & Schaeffer, R. (2006). A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. *Energy*, *31*(2), 181-207.

Liddle, B., & Lung, S. (2014). Might electricity consumption cause urbanization instead? Evidence from heterogeneous panel long-run causality tests. *Global Environmental Change*, *24*, 42-51.

Liddle, B., & Messinis, G. (2015). Which comes first–urbanization or economic growth? Evidence from heterogeneous panel causality tests. *Applied Economics Letters*, *22*(5), 349-355.

Liddle, B., (2013). The energy, economic growth, urbanization nexus across development: Evidence from heterogeneous panel estimates robust to cross-sectional dependence. *The Energy Journal*. 34, 223–244

Lin, B., & Liu, C. (2016). Why is electricity consumption inconsistent with economic growth in China? *Energy Policy*, *88*, 310-316.

Lin, B., Omoju, O. E., & Okonkwo, J. U. (2016). Factors influencing renewable electricity consumption in China. *Renewable and Sustainable Energy Reviews*. *55*, 687-696.

Liu, Y., & Xie, Y. (2013). Asymmetric adjustment of the dynamic relationship between energy intensity and urbanization in China. *Energy Economics*, *36*, 43-54.

Mahalik, M. K., Babu, M. S., Loganathan, N., & Shahbaz, M. (2017). Does financial development intensify energy consumption in Saudi Arabia? *Renewable and Sustainable Energy Reviews, 75*, 1022-1034.

Mandal, S. K., & Madheswaran, S. (2010). Causality between energy consumption and output growth in the Indian cement industry: An application of the panel vector error correction model (VECM). *Energy Policy*, *38*(11), 6560-6565.

Marques, A. C., Fuinhas, J. A., & Menegaki, A. N. (2016). Renewable vs non-renewable electricity and the industrial production nexus: Evidence from an ARDL bounds test approach for Greece. *Renewable Energy*, *96*, 645-655.

Marques, A. C., Fuinhas, J. A., & Nunes, A. R. (2016). Electricity generation mix and economic growth: What role is being played by nuclear sources and carbon dioxide emissions in France? *Energy Policy*, *92*, 7-19.

Mishkin, F. S. (2009). Globalization and financial development. *Journal of development Economics, 89(*2), 164-169.

Mozumder, P., & Marathe, A. (2007). Causality relationship between electricity consumption and GDP in Bangladesh. *Energy policy, 35*(1), 395-402.

Muhammad Adnan Hye, Q. (2011). Financial development index and economic growth: empirical evidence from India. *The Journal of Risk Finance*, *12*(2), 98-111.

Narayan, P. K., & Smyth, R. (2005). Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests. *Energy Policy, 33*, 1109–1116.

Narayan, P. K., & Smyth, R. (2009). Multivariate Granger causality between electricity consumption, exports and GDP: evidence from a panel of Middle Eastern countries. *Energy Policy*, *37*(1), 229-236.

Odhiambo, N. M. (2009a). Energy consumption and economic growth nexus in Tanzania: An ARDL bounds testing approach. *Energy Policy*, *37*(2), 617-622.

Odhiambo, N. M. (2009b). Electricity consumption and economic growth in South Africa: A trivariate causality test. *Energy Economics, 31*, 635–640.

Ozatac, N., Gokmenoglu, K. K., & Taspinar, N. (2017). Testing the EKC hypothesis by considering trade openness, urbanization, and financial development: the case of Turkey. Environmental Science and Pollution Research, 1-12 (In Press).

Ozturk, I. (2010). A literature survey on energy–growth nexus. *Energy policy*, *38*(1), 340-349.

Ozturk, I., & Acaravci, A. (2011). Electricity consumption and real GDP causality nexus: Evidence from ARDL bounds testing approach for 11 MENA countries. *Applied Energy*, *88*(8), 2885-2892.

Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics, 36*, 262–267.

Paul, S., & Bhattacharya, R. N. (2004). Causality between energy consumption and economic growth in India: a note on conflicting results. *Energy economics*, *26*(6), 977-983.

Parshall, L., Gurney, K., Hammer, S. A., Mendoza, D., Zhou, Y., & Geethakumar, S. (2010). Modeling energy consumption and CO 2 emissions at the urban scale: methodological challenges and insights from the United States. *Energy Policy*, *38*(9), 4765-4782.

Perron, P., Vogelsang, T.J., (1992). Non-stationarity and level shifts with an application to purchasing power parity. *Journal of Business and Economic Statistics 10,* 301–320.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335-346.

Poumanyvong, P., & Kaneko, S. (2010). Does urbanization lead to less energy use and lower CO 2 emissions? A cross-country analysis. *Ecological Economics*, *70*(2), 434-444.

Pradhan, R. P., Arvin, M. B., Bahmani, S., Hall, J. H., & Norman, N. R. (2017). Finance and growth: Evidence from the ARF countries. *The Quarterly Review of Economics and* Finance.

Rafindadi, A. A., & Ozturk, I. (2015). Natural gas consumption and economic growth nexus: Is the 10th Malaysian plan attainable within the limits of its resource? *Renewable and Sustainable Energy Reviews*, *49*, 1221-1232.

Rafindadi, A. A., & Ozturk, I. (2016). Effects of financial development, economic growth and trade on electricity consumption: evidence from post-Fukushima Japan. *Renewable and Sustainable Energy Reviews, 54*, 1073-1084.

Rosenberg, N. (1998). The role of electricity in industrial development. *The Energy Journal*, 7-24.

Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy Policy, 38,* 2528–2535.

Sadorsky, P. (2011). Financial development and energy consumption in Central and Eastern European frontier economies. *Energy Policy, 39*, 999–1006.

Salahuddin, M., Gow, J., & Ozturk, I. (2015). Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in gulf cooperation council countries robust? *Renewable and Sustainable Energy Review*, 51, 317–326.

Salim, R. A., & Shafiei, S. (2014). Urbanization and renewable and non-renewable energy consumption in OECD countries: An empirical analysis. *Economic Modelling*, *38*, 581-591.

Sbia, R., Shahbaz, M., & Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. *Economic Modelling*, 36, 191–197.

Sbia, R., Shahbaz, M., & Ozturk, I. (2017). Economic growth, financial development, urbanisation and electricity consumption nexus in UAE. *Economic Research-Ekonomska Istraživanja*, 1-23.

Shahbaz, M. (2012). Does trade openness affect long run growth? Cointegration, causality and forecast error variance decomposition tests for Pakistan. *Economic Modelling*, *29*(6), 2325-2339.

Shahbaz, M., & Feridun, M. (2012). Electricity consumption and economic growth empirical evidence from Pakistan. *Quality & Quantity*: International Journal of Methodology, 46(5), 1583–1599

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., Khan, S., & Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis. *Energy Economics*, 40, 8–21.

Shahbaz, M., Sbia, R., Hamdi, H., & Ozturk, I. (2014). Economic growth, electricity consumption, urbanization and environmental degradation relationship in the United Arab Emirates. *Ecological Indicators*, 45, 622-631.

Shahbaz, M., Mallick, H., Mahalick, M.K., Sadorsky, P., (2016). The role of globalization on the recent evolution of energy demand in India: Implications for sustainable development. *Energy Economics* 55, 52-68.

Shahbaz, M., Van Hoang, T. H., Mahalik, M. K., & Roubaud, D. (2017). Energy consumption, financial development and economic growth in India: New Evidence from a nonlinear and asymmetric analysis. *Energy Economics*, 63, 199-212.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In Festschrift in Honor of Peter Schmidt (pp. 281-314). Springer New York.

Shiu, A., & Lam, P. L. (2004). Electricity consumption and economic growth in China. *Energy policy*, *32*(1), 47-54.

Shrestha, M. B., & Chowdhury, K. (2005). A sequential procedure for testing unit roots in the presence of a structural break in time series data.

Solarin, S. A. (2011). Electricity consumption and economic growth: Trivariate investigation in Botswana with capital formation. *International Journal of Energy Economics and Policy*, *1*(2), 32.

Solarin, S. A., & Shahbaz, M. (2013). Trivariate causality between economic growth, urbanisation and electricity consumption in Angola: Cointegration and causality analysis. *Energy Policy*, *60*, 876-884.

Soytas, U., & Sari, R. (2003). Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. *Energy economics*, *25*(1), 33-37.

Stern, D. I. (2000). A multivariate cointegration analysis of the role of energy in the US macroeconomy. *Energy Economics*, *22*(2), 267-283.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy policy*, *37*(1), 246-253.

Templet, P. H. (1999). Energy, diversity and development in economic systems; an empirical analysis. *Ecological Economics*, *30*(2), 223-233.

Twerefou, D. K., Akoena, S. K., Agyire-Tettey, F. K., & Mawutor, G. (2007). Energy consumption and economic growth: evidence from Ghana.

Tursoy, T., & Faisal, F. (2016). Causality between stock price and GDP in Turkey: An ARDL Bounds Testing Approach. *Romanian Statistical Review*, *64*(4), 3-19.

Wolde-Rufael, Y., (2010). Bounds test approach to cointegration and causality between nuclear energy consumption and economic growth in India. *Energy Policy* 38, 52-58

World Bank, (2017). World Development Indicators. Available at: (http://www.worldbank.org).

Xie, P., Tan, Z., Hou, J.-C., & Wang, M. (2009). Analysis on dynamic relationship between urbanization and electricity consumption level in China. *Power System Technology*, 33, 86–92.

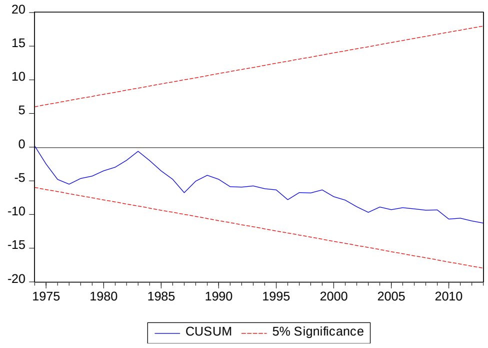
Xu, S. (2012). The impact of financial development on energy consumption in China: Based on SYSGMM estimation. *Advanced Materials Research*, 527, 2977–2981.

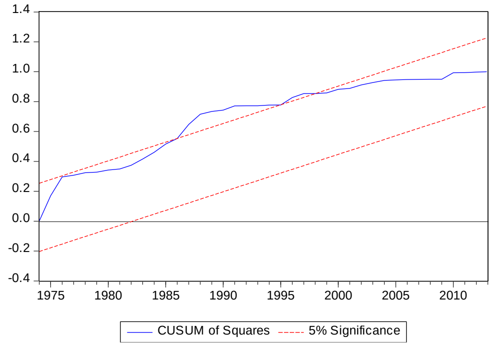
Zhang, C., & Lin, Y. (2012). Panel estimation for urbanization, energy consumption and CO2 emissions: A regional analysis in China. *Energy Policy*, 49, 488–498.

Zhao, Y., & Wang, S. (2015). The relationship between urbanization, economic growth and energy consumption in China: an econometric perspective analysis. *Sustainability*, *7*(5), 5609-5627.

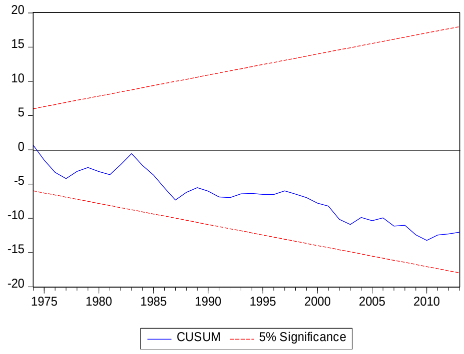
Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of business & economic statistics*, *20*(1), 25-44.

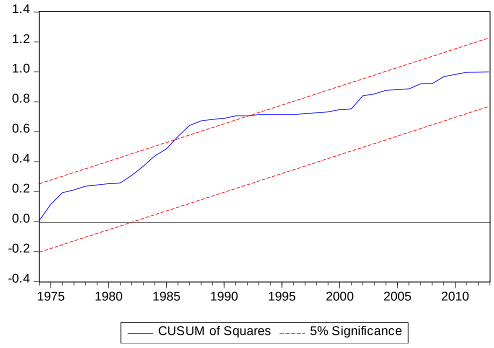
Appendix 1



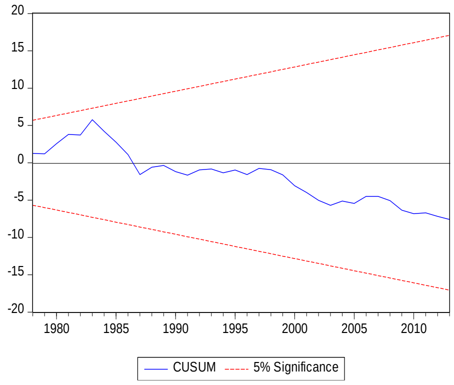


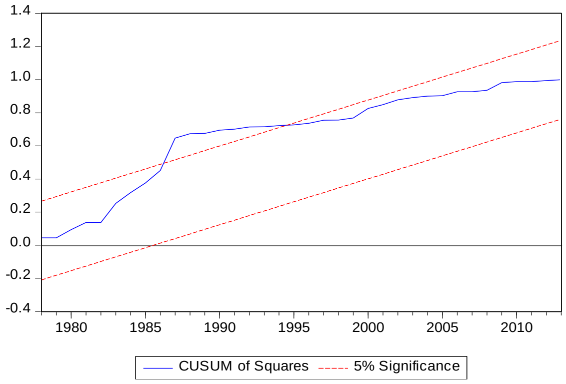
CUSUM and CUSUM SQ for Short-run coefficient in which the blue-line is in between the two red lines at 5%.





CUSUM and CUSUM SQ for Short-run coefficient in which the blue-line is in between the two red lines at 5%





CUSUM and CUSUM SQ for the Short-run coefficient in which the blue-line is in between the two red lines at 5%.

Appendix 2. List of publications during PhD.

1. Türsoy, T., & **Faisal, F.** (2017) "Validity of F-H Hypothesis in Small Isolated Island Economy: An Application of the Combined Cointegration Approach", *Asia Pacific Journal of Accounting and Economics*. **(SSCI, Scopus) Web of Science** http://dx.doi.org/**10.1080/16081625.2017.1284597**
2. **Faisal, F.,** Türsoy, T. and Günsel Reşatoğlu, N., (2017), "Is there any Causality between Financial Development, Energy Consumption and Economic Growth in Pakistan? Evidence from ARDL Bounds Testing Approach and Vector Error Correction Model", *International Journal of Ecological Economics and Statistics*, Issue No. 2, Vol. 38, in the press**. (ESCI and Scopus) Web of Science**
3. Pervaiz, R. **Faisal, F**., Nedime S. (2017) Practice of consanguinity and attitude towards risk in a Pashtun population of KP-Pakistan since IN PRESS (ACCEPTED) *Journal of biosocial sciences, Cambridge University press.* Forthcoming**. (SSCI, Scopus) (Web of Science)**
4. Pervaiz, R., Pinar T, **Faisal, F.,** Nedime S. (2017) Incidence of Cancer in Turkish Republic of Northern, Cyprus. *Turkish Journal of Medical Sciences*,47, (2017), 523-530 **(SCI expanded, SCOPUS) Web of Science**
5. **Faisal, F.,** Muhamad, P. M., Tursoy, T., (2017), "Impact of Economic Growth, Foreign Direct Investment and Financial Development on Stock Prices in China: Empirical Evidence from Time Series Analysis", *International Journal of Economics and Financial Issues*, 2017, 7(1), 97-105. **(Scopus, DOAJ)**
6. Tursoy, T., & **Faisal, F.** (2016). "Causality between stock price and GDP in Turkey: An ARDL Bounds Testing Approach". *Romanian Statistical Review*, 64(4), 3-19. **(ESCI, web of Science)**
7. **Faisal F.,** Türsoy, T. and Günsel Reşatoğlu, N., (2016), "Energy Consumption, Electricity, and GDP Causality; The Case of Russia, 1990-2011", *Procedia Economics and Finance* 39: 653-659 · December 2016. **(Web of Science)**
8. **Faisal.F,** Türsoy, T. and Günsel Reşatoğlu, N., (2016), "Do Savings and Income Affect Energy Consumption? An Evidence from G-7 Countries",

Procedia Economics and Finance 39: 510-519 · December 2016. **. (Web of Science)**

9. **Faisal,F.** & Tursoy, T.,(2017). Impact of energy consumption on economic growth. An Empirical evidence from non-granger causality. *Accepted conference paper* going to be held at Budapest ICSCCW 2017. **(Web of science (CPCI) and Scopus)**
10. Tursoy, T., & **Faisal, F.** (2016). Re-testing for financial integration of the Turkish Stock Market and the US Stock Market: An Evidence from co-integration and error correction models. Accepted and forthcoming indexed in **ESCI (Web of Science).**
11. Faisal, F., Türsoy, T. and Günsel Reşatoğlu, N., (2017) "Is Export-Led Growth Hypothesis Exist in Saudi Arabia? Evidence from an ARDL Bounds Testing Approach", Asian Journal of Economic Modeling, 5(1), 110-117. (REPEC)
12. **Faisal. F**, TARIQ, M., & JAN, F. A. (2015). Financial Performance of Banks in Pakistan: A Comparative Analysis of Public and Private Sectors. VFAST Transactions on Education and Social Sciences, 6(2). **(DOAJ)**
13. Pervaiz, R. **Faisal.F**,(2017). Breast cancer outcome in Africa is associated with socioeconomic development and health care setups. Accepted in *World cancer research Journal. Indexed in* ***Web of Science (ESCI) forthcoming.***
14. Pervaiz, R. **Faisal.F**,(2017). Cancer incidence and mortality are associated with human development index and health set-up in Africa. *Forthcoming* **Indexed in both web of Science and Scopus) Journal of Egyptian national cancer institute.**
15. **Faisal, F.** Tursoy. T., Ercantan. O (2017). The relationship between energy consumption and economic growth: Evidence from non-Granger causality test. (Accepted for ICSCCW 2017 Indexed in SCOPUS and CPCI Web of Science).
16. Malaika. S. **Faisal, F.** Günsel Reşatoğlu, N. (2017). Influence of energy use, foreign direct investment and population growth on unemployment for Russian Federation - (Accepted for ICSCCW 2017 Indexed in SCOPUS and CPCI Web of Science).
17. **Faisal, F**., Türsoy, T. and Günsel Reşatoğlu, N., (2017) "Economic growth and electricity consumption: Empirical evidence from Iceland" Economic Research-Ekonomska Istraživanja.(SSCI and SCOPUS).