NEAR EAST UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
BUSINESS ADMINISTRATION PROGRAM

EMPIRICAL RELATIONSHIP BETWEEN CARBON DIOXIDE EMISSIONS, GROSS DOMESTIC PRODUCT AND ENERGY CONSUMPTION FOR DEVELOPING AND DEVELOPED COUNTRIES, and EFFECT of THE KYOTO PROTOCOL ON DEVELOPED AND DEVELOPING COUNTRIES

EMRAH BEŞE

PhD THESIS

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ACCEPTANCE/APPROVAL

We as the jury members certify the 'EMPIRICAL RELATIONSHIP BETWEEN CARBON DIOXIDE EMISSIONS, GROSS DOMESTIC PRODUCT AND ENERGY CONSUMPTION FOR DEVELOPING AND DEVELOPED COUNTRIES, and EFFECT of THE KYOTO PROTOCOL ON DEVELOPED AND DEVELOPING COUNTRIES' prepared by the Emrah Beşe defended on ...../..../.... has been found satisfactory for the award of degree of Phd

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DECLARATION

I Emrah Beşe, hereby declare that this dissertation entitled ‘Empirical Relationship Between Economic Growth, Energy Consumption and CO2 Emissions, and Effect of the Kyoto Protocol Over CO2 Emissions’ has been prepared myself under the guidance and supervision of ‘Dr. Salih Kalaycı’ in partial fulfilment of the Near East University, Graduate School of Social Sciences regulations and does not to the best of my knowledge breach and Law of Copyrights and has been tested for plagiarism and a copy of the result can be found in the Thesis.

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To My Friends

ACKNOWLEDGEMENTS

I would like to thank my family for their continuous support during my study.

ABSTRACT

EMPIRICAL RELATIONSHIP BETWEEN CARBON DIOXIDE EMISSIONS, GROSS DOMESTIC PRODUCT AND ENERGY CONSUMPTION FOR DEVELOPING AND DEVELOPED COUNTRIES,
and EFFECT of THE KYOTO PROTOCOL ON DEVELOPED AND DEVELOPING COUNTRIES

In this study, the relationship between income and environmental degradation is discussed. For developing countries, which are Argentina, Egypt, Ghana, Iran, Kenya, Malaysia and Nigeria, environmental Kuznets curve hypothesis is tested and rejected for all developing countries for the period between 1971 and 2014. For developed countries, which are Austria, Belgium, Sweden, Denmark, Spain and UK, environmental Kuznets curve hypothesis is tested and rejected for all developed countries for the period between 1960 and 2014. Relationship between income and environmental Kuznets curve is examined for developed and developing countries by ARDL model, NARDL model, bootstrap ARDL model and Johansen Cointegration tests. Coal consumption environmental Kuznets curve is also tested besides environmental Kuznets curve for New Zealand and Finland by replacing CO2 with coal consumption as dependent variable. Coal consumption environmental Kuznets curve is confirmed for New Zealand and Finland for the period 1980 and 2015, and 1980 and 2013 respectively. Existence of coal consumption environmental Kuznets curve indicates the success of the relevant countries' policies for climate change. Coal consumption environmental Kuznets curve is investigated by ARDL and bootstrap ARDL models.

Kyoto Protocol's effects for developing countries and developed countries are analyzed for the period between 1980 and 2014, and 1971 and 2014 respectively. Since no significant relationship between GDP and CO2 is found for developed and developing countries in the analysis, it is concluded that Kyoto Protocol did not have a significant effect on CO2 emissions for the relevant countries in the study.

Keywords: Environmental Kuznets curve, Developing countries, Developed countries, Coal consumption environmental Kuznets curve, Kyoto protocol

ÖZ

EMPIRICAL RELATIONSHIP BETWEEN CARBON DIOXIDE EMISSIONS, GROSS DOMESTIC PRODUCT AND ENERGY CONSUMPTION FOR DEVELOPING AND DEVELOPED COUNTRIES,
and EFFECT of THE KYOTO PROTOCOL ON DEVELOPED AND DEVELOPING COUNTRIES

Bu çalışmada, kişi başına düşen milli gelir ile çevre kirliliği arasındaki ilişki incelenmiştir. Gelişmekte olan ülkeler için, Arjantin, Mısır, Gana, İran, Kenya, Malezya ve Nijerya, çevresel Kuznets eğrisi test edilmiş ve tüm bu gelişmekte olan ülkeler için 1971 ve 2014 arasını kapsayan zaman dilimi için çevresel Kuznets eğrisi hipotezi reddedilmiştir. Gelişmiş olan ülkeler için, Avusturya, Belçika, İsveç, Danimarka, İspanya ve İngiltere, çevresel Kuznets eğrisi test edilmiş ve tüm bu gelişmiş olan ülkeler için 1960 and 2014 arasını kapsayan zaman dilimi için çevresel Kuznets eğrisi hipotezi reddedilmiştir. Gelişmiş ve gelişmekte olan ülkeler için kişi başına düşen milli gelir ve çevre kirliliği arasındaki ilişki ARDL, NARDL, bootstrap ARDL modelleri ve Johansen eşbütünleşme testleri ile incelenmiştir. Kömür tüketimi çevresel Kuznets eğrisi, bu çalışmada çevresel Kuznets eğrisinin yanında, Yeni Zelanda ve Finlandiya için test edilmiştir kömür tüketiminin karbon emisyonunun bağımlı değişken olarak yerini alması ile. Kömür tüketimi çevresel Kuznets eğrisi Yeni Zelanda ve Finlandiya için sırası ile 1980 ve 2015 arası zaman dilimi ve 1980 ve 2013 arası zaman dilimi için doğrulanmıştır. Kömür tüketimi çevresel Kuznets eğrisinin bu ülkeler için doğrulanması bu ülkelerin kömür tüketimi ile ilgili olan iklim değişikliği politikalarının başarısını göstermektedir. Kömür tüketimi çevresel Kuznets eğrisi ARDL ve bootstrap ARDL modelleri ile incelenmiştir.

Kyoto Protokolünün gelişmiş ve gelişmekte olan ülkeler üzerindeki etkileri sırası ile 1971 ve 2014 arası zaman dilimi ve 1980 ve 2014 arası zaman dilimi için incelenmiştir. Kişi başına düşen milli gelir ve karbon salınımı arasında önemli bir ilişki bulunamadığı için, çalışma Kyoto Protokolünün karbon salınımı üzerine önemli bir etkisi olmadığı yönünde sonuçlandırılmıştır.

Anahtar Kelimeler: Çevresel Kuznets eğrisi, Gelişmekte olan ülkeler, Gelişmiş ülkeler, Kömür tüketimi çevresel Kuznets eğrisi, Kyoto protokolü

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ABBREVATIONS

AIC : Akaike Information Criteria

ARDL : Autoregressive Distributed Lag

BDD : Banerjee, Dolado and Mestre

BEW : Block Exogeneity Wald

CO : Breusch-Godfrey Serial Correlation LM Test

CO2 : Carbon dioxide emissions

CS : Coal Consumption

CSQM : Cusum Square Test

CSSM : Cusum Test

C.V. : Critical Value

D.V. : Dependent Variable

ECM : Error Correction Model

EI. : Eigenvalue

EKC : Environmental Kuznets Curve

ENC : Energy consumption

EXCL. : Excluded

FPE : Final Prediction Error

GDP : Gross domestic per capita

HE : Heteroscedasticity Test Breusch-Pagan-Godfrey

HQ : Hannan-Quinn Information Criterion

IRRA : Impulse Response Analysis

JCT : Johansen Cointegration Test

LR : Sequential modified LR test statistic

LRR : Long run results

MAX. ER. : Maximum Eigenvalue

MG : Mean Group

NARDL: Non-linear Autoregressive Distributed Lag

NO : Normality Test

PB. : Probability

PER. : Period

PMG : Pooled Mean Group

PSS : Pesaran, Shin and Smith

RE : Ramsey Reset Test

SC : Schwarz information criterion

SQ : Square of gross domestic per capita

SRR : Short run results

TR : Trace

TR. STAT. : Trace Statistics

UCRT : Unrestricted Cointegration Rank Test

UR **:** Unit Root Test

VAR **:** Vector Autoregressive Model

VDDA **:** Variance Decomposition Analysis

VECM **:** Vector Error Correction Model

VGC **:** Var Granger Causality

VMSR : VAR Model Stability Results

VRHT : VAR Residual Heteroskedasticity Tests

VRSC : VAR Residual Serial Correlation

INTRODUCTION

Kuznets (1955) studied the relationship between income and income inequality. Kuznets discovered inverted U shape between income and income inequality. EKC which is named after Kuznets, is the study of relationship between income and environmental degradation. EKC is studied in the literature mainly with CO2 being dependent variable and GDP is being the independent variable. The Kyoto Protocol is an agreement also discussed in the EKC literature. Effect of the Kyoto Protocol is discussed in the EKC literature. The Kyoto Protocol is an agreement that is signed by developed and developing countries to lower signing countries' current emissions by a certain level. Effectiveness of Kyoto Protocol is discussed in the literature that whether Kyoto Protocol had a significant impact on reducing CO2 levels of signing countries. Since sustainability is the one of the main issues in the world, studies for EKC and the agreements for reduction of greenhouse gases carry importance. In this study, EKC hypothesis is examined for developed and developing countries by using examining the relationships such as asymmetric relationships between the variables with NARDL model by Shin, Yu and Greenwood-Nimmo (2014) to cover the current gaps in the EKC literature. In this study, the Kyoto Protocol is investigated by using Pooled Mean Group Estimator based on Error Correction Model by Pesaran, Shin and Smith (1999), Cross-Sectional Augmented Distributed Lag estimator (CS-DL) by Chudik, Mohaddes, Pesaran and Raissi (2016), Cross-Sectional ARDL estimator based on ARDL model by Chudik, Mohaddes, Pesaran and Raissi (2016) and Dynamic Common Correlated Effects Estimator model by Chudik and Pesaran (2015) to cover the gaps in the EKC literature.

Climate change is a topic worldwide discussed by scientists, politicians and individuals. Carbon dioxide is also discussed besides climate change since it is one of the major causes for climate change and one of main greenhouse gas emissions which are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and Sulphur hexafluoride. To cope with climate change and reduce CO2, many initiatives take place on individual

country level and global level. For global initiatives Paris Agreement and Kyoto protocol can be mentioned as two of them.

Kyoto Protocol, as being one of the global initiatives, an international agreement which was signed and ratified with different parties on December 11, 1997 is one of the main efforts of humanity to cope with climate change and reduce CO2 emissions. Developing and developed countries aim to reduce their GHG (Green House Gases) emissions by taking place in global initiatives. The protocol was prepared under the guidance of United Nations Framework Convention on Climate Change (UNFCC). It was first started with 37 industrialized countries and the European Union but today almost all countries involved in the protocol. Not all countries ratified Kyoto Protocol such as United States of America (USA). Kyoto Protocol went into practice by 2005 and by having a common objective for GHG emissions reduction, it also provided each participant country with a different commitment for emissions. Kyoto Protocol's first commitment period for ratified parties was between 2008 and 2012. First commitment period required involved countries to reduce their GHG emissions by 5 percent below 1990 levels. Updates to protocol were made in 2011 in Morocco and in 2012 in Qatar. After 2012 meeting in Qatar, second commitment period was decided to be started between 2013 and end of 2020. New common objective was to reduce GHG emissions 18 percent below 1990 levels. Many discussions take place in the media and scientific community whether Kyoto Protocol is successful and its contribution to the reduction level in CO2 and GHG worldwide.

Kyoto Protocol was not created just being a binding agreement by participant countries and the United Nations, but it was also created to set up new initiatives to cope with GHG emissions against climate change. These initiatives are carbon trading, Clean Development Mechanism and Joint Implementation. The main common point of these initiatives is the participant countries in the Kyoto Protocol can trade their excess carbon allowance on the carbon market and gain income. Also, in clean development mechanism, a participant country can make a green investment inside its borders to gain carbon credits in order to count in further commitment periods toward its

emissions allowances. In joint implementation, a participant country can make a green investment in another country's territory to gain carbon credits in order to count in further commitment periods toward its emissions allowances.

Kyoto Protocol is discussed besides Environmental Kuznets Curve (EKC), which states income increase with CO2 to a certain level and after that level is reached CO2 starts to decrease while income increases, as well as climate change. The impact of Kyoto Protocol on EKC is one of the determinants for countries that are involved in the protocol to determine their policy implications towards their coping strategy with climate change.

The main question of this study is that whether income has a significant effect on environmental degradation in the long run. The other question is that whether Kyoto Protocol has a significant effect on CO2 emissions. Also, coal consumption environmental Kuznets curve is investigated in this study. Hao, Liu, Weng and Gao (2016) analyzed coal consumption environmental Kuznets curve in China for a panel study. This is the only study in the EKC literature. Coal consumption environmental Kuznets curve is investigated in New Zealand and Finland in this study to fill the gap in the EKC literature.

The limitations of this study are the studied countries and the time period studied for these studied countries.

In Chapter 1, literature review for single country studies are examined for the EKC literature. Studies for the effect of Kyoto Protocol on CO2 emissions are examined besides single country studies.

In Chapter 2, data used in the study and the methodology of the study are explained in detail. The period of the study is determined according to the availability of the data for the studied countries. Developing countries in the study are Argentina, Egypt, Ghana, Iran, Kenya, Malaysia and Nigeria. Developed countries in the study are Austria, Belgium, Sweden, Denmark, Spain and UK. New Zealand and Finland are examined for coal consumption environmental Kuznets curve. Developing countries in the panel study are

Argentina, Egypt, Ghana, India, Iran, Kenya, Malaysia, Morocco, Nigeria and Turkey. Developed countries in the panel study are Sweden, Denmark, Australia, Portugal, Austria, Canada, Finland, Spain and UK.

In Chapter 3, EKC is examined for developing countries which are Argentina, Egypt, Ghana, Iran, Kenya, Malaysia and Nigeria. ARDL, NARDL and bootstrap ARDL models are used in this chapter.

In Chapter 4, EKC is examined for developed countries which are Austria, Belgium and Sweden. ARDL, NARDL and bootstrap ARDL models are used in this chapter. Finland is analyzed by bootstrap ARDL model.

In Chapter 5, EKC is examined for Denmark, UK and Spain. ARDL, NARDL and bootstrap ARDL models are used in this chapter. Toda and Yamamoto granger non-causality test and VAR granger causality test are used for causal relationships between the variables. Cointegration test by Johansen is used for UK.

In Chapter 6, coal consumption environmental Kuznets curve is examined for New Zealand and Finland. ARDL, bootstrap ARDL and ARDL Dynamic Multiplier models are used in this chapter.

In Chapter 7, the effect of the Kyoto Protocol on developing countries are examined for Argentina, Egypt, Ghana, India, Iran, Kenya, Malaysia, Morocco, Nigeria and Turkey.

In Chapter 8, the effect of the Kyoto Protocol on developed countries are examined for Sweden, Denmark, Australia, Portugal, Austria, Canada, Finland, Spain and UK.

Final parts of this study are discussion and conclusion parts. In discussion and conclusion parts, overall findings of the study are discussed.

CHAPTER 1
LITERATURE REVIEW

Single country studies in the literature of carbon Kuznets curve is discussed in part 1.1. Majority of the studies in the EKC literature analyzed multi-country studies and panel studies. Impact of the Kyoto Protocol studies in the literature of carbon Kuznets curve is discussed in part 1.2.

1.1 Single country studies in the literature of Carbon Kuznets Curve

For Austria, Benavides et al. (2017) used ARDL bounds test for the relationship between methane emissions, economic growth, electricity production from renewable resources except hydro and trade openness for the period 1970 and 2012. Benavides et al. (2017) verified EKC for Austria. Benavides et al. (2017) showed that there were long-run causality running from GDP, square of GDP, electricity production from renewable resources and trade openness to methane emissions for Austria.

For Canada, He and Richard (2010) examined the relationship between CO2 and GDP for Canada between 1948 and 2004, and did not confirm EKC for Canada and found positive correlation between CO2 and GDP.

Day and Grafton (2003) examined the relationship between CO2, carbon monoxide, TSP (Total Suspended Particulate Matter) and Sulphur Dioxide (SO2), and GDP, and found no long-run relationship between GDP and CO2, carbon monoxide, TSP (Total Suspended Particulate Matter) and Sulphur Dioxide (SO2) for Canada.

For Portugal, Shahbaz et al. (2010) examined the relationship between CO2, GDP, energy consumption, trade openness and urbanization by ARDL model for the period between 1971 and 2008. EKC is confirmed for Portugal and long-run relationship is found between variables.

For USA, Dogan and Turkekul (2016) examined the relationship between GDP, square of GDP, CO2, energy consumption, trade openness, urbanization and financial development for USA between 1960 and 2010. ARDL model is used. Long-run relationship exists between variables. EKC is not confirmed for USA.

For India, Ahmad et al. (2016) examined the relationships between CO2, GDP and energy consumption for India at aggregated and disaggregated levels. Long-run relationship between variables and EKC hypothesis are confirmed for India at aggregated and disaggregated levels of energy consumption (Coal, Gas, Electricity and Oil) in the long-run. In the short run EKC is valid only for gas energy consumption. Time period of the study is between 1971 and 2014 and ARDL model is used.

Kanjilal and Ghosh (2013) examined the relationships between CO2, GDP, energy consumption and trade openness for India with ARDL model and threshold cointegration with structural breaks between 1971 and 2008. EKC hypothesis is confirmed for India.

Tiwari et al. (2013) examined the relationship between CO2, GDP, coal consumption and trade openness for India between 1966 and 2011 by using ARDL model. EKC hypothesis is confirmed for India both in the short-run and long-run.

Boutabba (2014) examined the relationships between CO2, GDP, energy consumption, financial development and trade openness between 1971 and 2008 for India. ARDL model is used. Long-run relationship is found between variables and EKC hypothesis is confirmed for India both in the short-run and long-run.

For Iran, Saboori and Soleymani (2011) examined the relationships between CO2, GDP and energy consumption between 1971 and 2007. ARDL model is used. Long-run relationship between variables is found but EKC hypothesis is not confirmed for Iran.

Taghvaee and Parsa (2015) examined the relationships between CO2, and capital value added from manufacturing and mining, and services sectors and rural population in Iran. EKC hypothesis is not confirmed between value added in manufacturing and mining sectors and CO2, and between services sector and CO2.

Asghari (2012) examined the relationship between GDP and CO2 in Iran by two-stage least squares method between 1980 and 2008. Asghari (2012) did not confirm EKC for Iran.

For Malaysia, Begum et al. (2015) examined the relationships between CO2, GDP, population and energy consumption for Malaysia between 1980 and 2009. EKC hypothesis is not confirmed for Malaysia. ARDL model and dynamic ordinary least squared (DOLS) are used.

Azlina et al. (2014) examined the relationships between industrialization, GDP, CO2, renewable energy use and energy consumption in the transport sector for Malaysia between 1975 and 2011. EKC hypothesis is not confirmed for Malaysia.

Saboori et al. (2012) examined the relationships between GDP and CO2 for Malaysia between 1980 and 2009. ARDL model is used. EKC hypothesis is confirmed for Malaysia.

Saboori and Sulaiman (2013) examined the relationships between CO2, GDP and energy consumption at aggregated and disaggregated (oil, gas, electricity and gas) levels for Malaysia between 1980 and 2009. EKC hypothesis is not confirmed at aggregated level but confirmed at disaggregated levels.

Gill et al. (2017) examined the relationship between CO2, GDP and renewable energy between 1970 and 2011 for Malaysia. EKC hypothesis is not confirmed for Malaysia. ARDL model is used.

Lau et al. (2014) examined the relationships between CO2, GDP, FDI and trade openness for Malaysia between 1970 and 2008. EKC hypothesis is confirmed for Malaysia both in the long-run and short-run.

Sulaiman et al. (2013) examined the relationships between CO2, GDP, trade openness and electricity generation from renewable energy supply between 1980 and 2009 for Malaysia. ARDL model is used. Long-run relationship between variables is confirmed and EKC hypothesis is confirmed for Malaysia.

For Morocco, Haq et al. (2016) examined the relationships between CO2, GDP, energy consumption and trade openness for Morocco between 1971 and 2011. Johansen cointegration model is used. EKC hypothesis is not confirmed for Morocco.

Kharbach and Chfadi (2017) examined the EKC hypothesis in the road transport sector in Morocco. Kharbach and Chfadi (2017) confirmed the EKC hypothesis in Morocco's road transport sector. Long run relationship between CO2, GDP and energy consumption in the road transport sector (Diesel Consumption) is confirmed for the period between 1971 – 2011 by VECM model.

For Nigeria, Chuku (2011) examined the relationship between GDP and CO2 by standard EKC equation and modified EKC equation. Johansen cointegration test is used. Chuku (2011) confirmed EKC hypothesis with standard EKC equation, and rejected EKC hypothesis with modified EKC equation (added several variables to the equation).

Oyinlola (2010) examined the relationship between CO2, GDP, FDI, manufacturing, energy consumption and traded stock in Nigeria between 1980 and 2008. EKC is not confirmed for Nigeria.

Akpan and Chuku (2011) examined the relationship between CO2 and GDP between 1960 and 2008. ARDL model is used. EKC hypothesis is not confirmed for Nigeria.

Olusegun (2009) examined the relationship between CO2 and GDP for Nigeria between 1970 and 2005. EKC hypothesis is not confirmed for Nigeria. Johansen cointegration model is used.

1.2 Impact of the Kyoto Protocol studies in the literature of Carbon Kuznets Curve

Grunewald and Martinez-Zarzoso (2016) analyzed the impact of the Kyoto Protocol on CO2 emissions for 170 countries over the period 1992 and 2009. They found that ratifying Kyoto Protocol had a significant effect on CO2 emissions and countries emit on average 7% less emissions that signed the protocol than those without.

Aichele and Felbermayr (2013) found that Kyoto Protocol had a statistically significant negative effect on CO2 emissions. The effect is close to 10 percent on CO2 emissions for panel countries.

Halkos and Tzeremes (2014) applied conditional full frontiers approach to analyze Kyoto Protocol's effect on CO2 emissions for a panel of 110 countries. They found a nonlinear relationship between the countries' duration in the protocol and their emission levels. They also found a nonlinear relationship between countries' agreement on emission level and their emission levels.

Kumazawa and Callaghan (2012) analyzed the impact of Kyoto Protocol on CO2 emissions for a panel of 177 countries for the period 1980 and 2006. They found structural breaks in the analysis of data which they mentioned as the effects of Kyoto Protocol. Panel version of Chow test is used. They also found that emissions decreased by increasing income in Annex B countries which signed the Kyoto Protocol. They also found industrial production negatively affected emissions in both Annex-B and non-Annex-B countries.

Mert and Çağlar (2017) analyzed the impact of Kyoto Protocol for 26 countries for the period 1960 and 2013 by using structural breaks. They found structural breaks between 1997 and 2006 for 19 countries in the study and mentioned them as the impact of Kyoto Protocol.

Almer and Winkler (2017) and Maamoun (2019) examined the effect of Kyoto Protocol by comparing the Kyoto Protocol scenario with no-Kyoto Protocol scenario. While Maamoun (2019) confirmed that the emission levels would be higher without the Protocol, Almer and Winkler (2017) found that there were no difference between the Kyoto Protocol scenario and no-Kyoto Protocol scenario.

CHAPTER 2
METHODOLOGY AND DATA OF THE STUDY

Data used in the study is explained in part 2.1. Methodology of the study is discussed in part 2.2. Methodology is explained in detail for each chapter.

2.1 Data

GDP is gross domestic product per capita. CO2 is carbon dioxide emissions per capita. ENC is energy consumption (kg of oil equivalent per capita). SQ is the square of gross domestic product. CS is coal consumption (million tonnes of oil equivalent). Data for CO2, GDP, SQ and ENC is retrieved from World Bank website. Data for CS is retrieved from U.S. energy information administration website.

2.2 Methodology

For time series analysis of developing countries, ARDL model by Pesaran, Shin and Smith (2001), NARDL model by Shin, Yu and Greenwood-Nimmo (2014) and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of test by Banerjee, Dolado and Mestre (1998) and bound test by Pesaran, Shin, & Smith (2001). ARDL model is used to investigate the symmetric relationships between variables whereas NARDL model is used to investigate the asymmetric relationships between the variables. ADF unit root test by Dickey & Fuller (1981) is applied to determine the levels of unit roots of the variables. The EKC hypothesis is investigated for Argentina, Egypt, Ghana, Iran, Kenya, Malaysia and Nigeria for the period between 1971 and 2014. Second model is used for Nigeria. First model is used for Argentina, Egypt,

Ghana, Iran, Kenya and Malaysia. The stability of the models is examined by CSSM, CSQM, HE, CO, RE and NO tests.

$$\ln(CO2)_t = r_0 + r_1 \ln(GDP)_t + r_2 \ln(GDP)_t^2 + r_3 \ln(EN)_t + e_t \quad (1)$$

$$\ln(CO2)_t = r_0 + r_1 \ln(GDP)_t + r_2 \ln(GDP)_t^2 + e_t \quad (2)$$

$$\ln(CO2)_t = r_0 + r_1 \ln(GDP)_t + r_2 \ln(EN)_t + e_t \quad (3)$$

$$\ln(CS)_t = r_0 + r_1 \ln(GDP)_t + r_2 \ln(GDP)_t^2 + e_t \quad (4)$$

For all models e is the error term and r_0, r_1, r_2 and r_3 are coefficients. For time series analysis in this study, ADF unit root test is used to determine the levels of unit roots of the variables.

For time series analysis of Austria and Belgium second model is used. ARDL model, NARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. ARDL model is used to investigate the symmetric relationships between variables whereas NARDL model is used to investigate the asymmetric relationships between the variables. The EKC hypothesis is investigated for Austria and Belgium for the period between 1960 and 2014. The stability of the models is examined by CSSM, CSQM, HE, CO, RE and NO tests.

For time series analysis of Sweden, first model is used. ARDL model, NARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. ARDL model is used to investigate the symmetric relationships between variables whereas NARDL model is used to investigate the asymmetric relationships between the variables. The EKC hypothesis is investigated for Sweden for the period between 1960 and 2014. The stability of the models is examined by CSSM, CSQM, HE, CO, RE and NO tests.

For time series analysis of Finland, first model is used. Bootstrap ARDL model is used. Bootstrap ARDL model used bootstrap versions of T test and F test. The EKC hypothesis is investigated for Finland for the period between 1960 and 2014.

For time series analysis of Denmark, first and third models are used. For CO2-GDP-ENC nexus, ARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. Toda and Yamamoto (1995) granger non-causality test is applied to examine the causal relationships between the variables. HE, CO and NO tests are applied for stability of the model. For VAR model, that is established to apply Toda and Yamamoto granger non-causality test, VAR model stability tests are applied. For CO2-GDP-SQ-ENC nexus, ARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. HE, CO and NO tests are applied for stability of the model. EKC hypothesis is investigated for Denmark for the period between 1960 and 2014.

For time series analysis of Spain, first and third models are used. For CO2-GDP-ENC nexus, ARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. Toda and Yamamoto granger non-causality test is applied to examine the causal relationships between the variables. HE, CO and NO tests are applied for stability of the model. For VAR model, that is established to apply Toda and Yamamoto granger non-causality test, VAR model stability tests are applied. For CO2-GDP-SQ-ENC nexus, ARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. HE, CO and NO tests are applied for stability of the model. EKC hypothesis is investigated for Spain for the period between 1960 and 2014.

For time series analysis of UK, first and third models are used. For CO2-GDP-ENC nexus, cointegration test by Johansen (1991) is applied for the variables. IRRA analysis and VDDA analysis are applied for the variables. VAR Granger causality test is applied to investigate the causal relationships between the variables. VAR stability tests are applied for the stability of VAR model. For CO2-GDP-SQ-ENC nexus, cointegration test by Johansen is applied for the variables. EKC hypothesis is investigated for UK for the period between 1960 and 2014.

For time series analysis of New Zealand and Finland, fourth model is used. For CS-GDP-SQ nexus, ARDL model and bootstrap ARDL model are used. Bootstrap ARDL model used bootstrap versions of T test and F test. ARDL Dynamic Multiplier model is applied to calculate short run and long run coefficients of the variables. Coal consumption environmental Kuznets curve is investigated for New Zealand and Finland for the period between 1980 and 2015, and the period between 1980 and 2013 respectively. The stability of the model is examined by CSSM, CSQM, HE, CO, RE and NO tests.

For panel data analysis, cross sectional dependency is tested in panel data. First generation panel unit root tests do not take cross sectional dependency into consideration. Since cross sectional dependency is found in panel data, second generation panel unit root tests are used. First generation panel unit root tests which are Im, Pesaran and Shin (2003) and Levin, Lin and Chu (2002) panel unit root tests are also used in the study. For second generation panel unit root tests, Pesaran (2004) cross section dependency test and Pesaran (2015) weak cross sectional dependency test are used. Panel cointegration test is optional so Westerlund (2007) Error Correction Based Bootstrap Panel Cointegration Test is applied only for developing countries for the period between 1971 and 1997 for CO2-GDP-SQ-ENC nexus and CO2-GDP-SQ nexus separately. Hausman (1978) test is applied first to decide between fixed effects and random effects model, then Hausman test is again applied to decide between mean group model and pooled mean group model.

For developing countries for the period between 1971 and 1997, Hausman test is applied separately for CO2-GDP-SQ-ENC nexus and CO2-GDP-SQ nexus. CS-ARDL and CCE-PMG models are applied for CO2-GDP-SQ nexus, and CS-DL model is applied for CO2-GDP-SQ-ENC nexus.

Dynamic Common Correlated Effects Estimator model by Chudik and Pesaran (2015) is used since there is cross sectional dependency in the data. For a dynamic model, there are three models that are used to estimate the long run coefficients. First one is Pooled Mean Group Estimator based on Error Correction Model by Pesaran, Shin and Smith (1999). Second one is the

Cross-Sectional Augmented Distributed Lag estimator (CS-DL) by Chudik, Mohaddes, Pesaran and Raissi (2016) which estimates long run coefficients directly from a dynamic model. Third one is Cross-Sectional ARDL estimator based on ARDL model by Chudik, Mohaddes, Pesaran and Raissi (2016) which first estimates short run coefficients then long run coefficients from a dynamic model. Although Hausman test results indicate PMG model, since there is cross sectional dependency in panel data, all three models are used. All three models provide cross sectional dependency test results. At the end of the analysis, cross sectional dependency test results are also checked for that there is no cross-sectional dependency in the analysis.

For developed countries between 1971 and 1997, CS-ARDL model is not applied. CCE-PMG and CS-DL models are applied for CO2-GDP-SQ-ENC nexus.

CHAPTER 3
EKC FOR DEVELOPING COUNTRIES

CO2-GDP-SQ-ENC nexus is examined for Argentina, Egypt, Ghana, Iran, Kenya and Malaysia. CO2-GDP-SQ nexus is examined for Nigeria. ARDL, NARDL and bootstrap ARDL models are used in the analysis.

3.1 Argentina

3.1.1 ARDL Model for Argentina

Unit root test results for Argentina are as in Table 1. According to unit root test results, CO2, GDP, SQ and ENC variables are at I(1) level. Lag length is determined according to lag length results in VAR model (see Table 2). F-statistics value of ARDL bounds test is 0.541522 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC by ARDL model. ARDL model for Argentina is stable according to stability test results (see Table 3, Figure 1 and Figure 2).

	Level	First Difference
CO2	-0.903493	-5.614990 (1%)
GDP	-0.720451	-5.398824 (1%)
SQ	-0.696829	-5.398799 (1%)
ENC	0.110569	-6.524269 (1%)

Table 1: UR Results for Argentina

Lag	LogL	LR	FPE	AIC	SC	HQ
0	251.8866	NA	4.87e-11	-12.39433	-12.22544	-12.33327
1	367.9539	203.1177*	3.29e-13*	-17.39769*	-16.55325*	-17.09237*
2	381.6901	21.29114	3.78e-13	-17.28451	-15.76451	-16.73492
3	390.1594	11.43355	5.88e-13	-16.90797	-14.71243	-16.11413
4	405.9224	18.12740	6.80e-13	-16.89612	-14.02502	-15.85802

Table 2: Lag Length Results for Argentina

	F-statistic	Jarque-Bera
RE Test	0.025491 (0.8740)	-
HE Test	1.889960 (0.1197)	-
CO Test	2.681161 (0.1103)	-
NO Test	-	2.661962 (0.264218)

Table 3: Stability Test Results for ARDL Model of Argentina

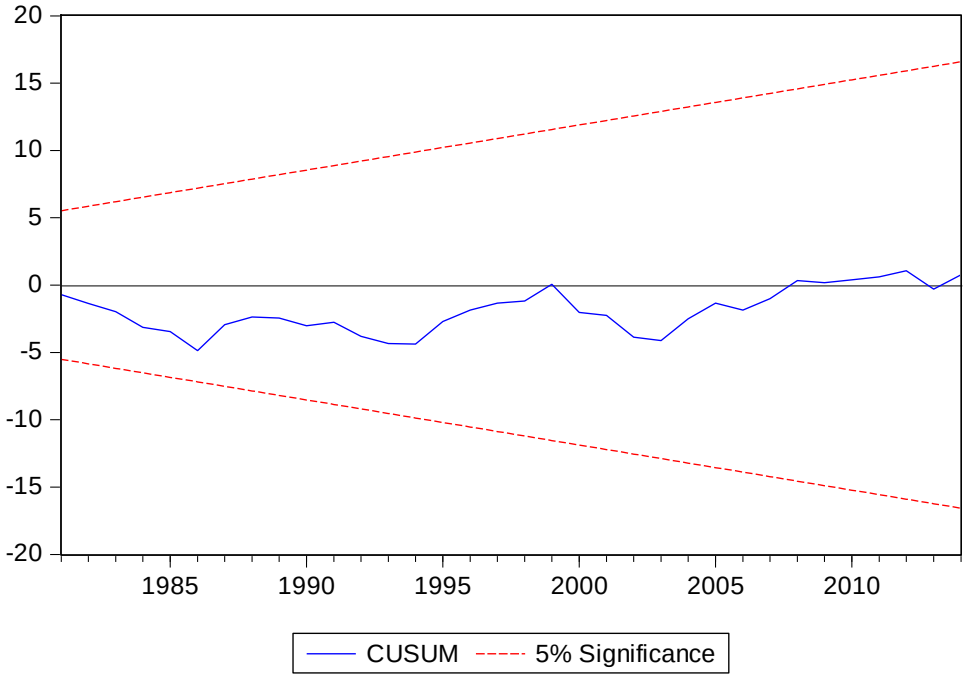

Figure 1: CSSM Test Results for ARDL Model of Argentina

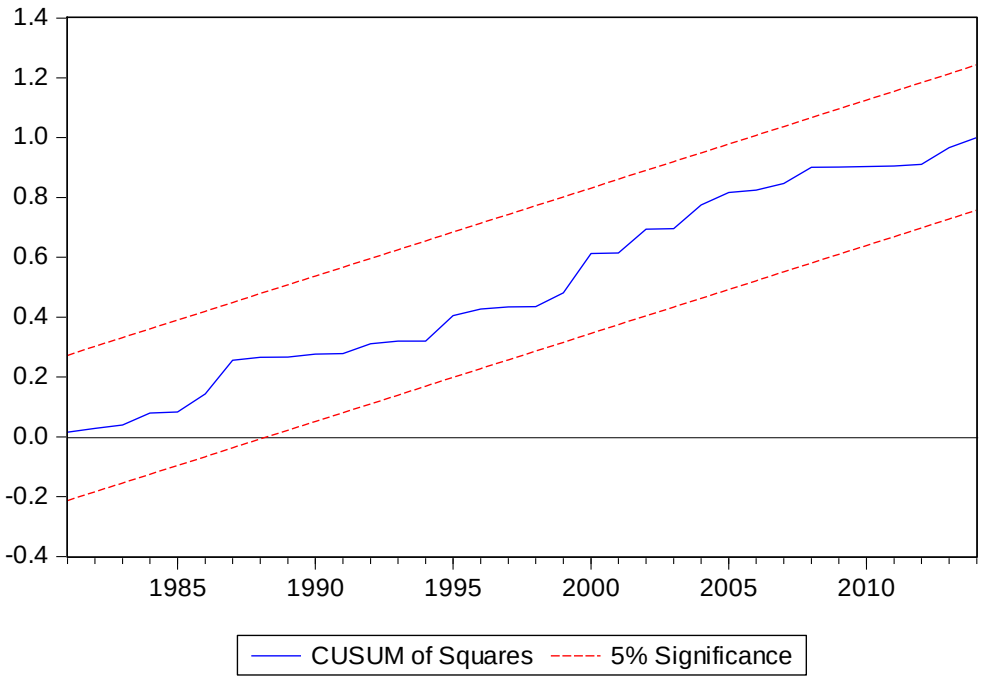

Figure 2: CSQM Test Results for ARDL Model of Argentina

3.1.2 NARDL Model for Argentina

Non-linear relationship is investigated between CO2, GDP, SQ and ENC by NARDL model. F-statistics value of NARDL bounds test is 2.099869 which is less than 2.45 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC by NARDL model. NARDL model is stable according to stability test results (see Table 4, Figure 3 and Figure 4).

	F-statistic	Jarque-Bera
RE Test	0.004902 (0.9446)	-
HE Test	0.689271 (0.6596)	-
CO Test	0.752316 (0.3918)	-
NO Test	-	0.678336 (0.776224)

Table 4: Stability Test Results for NARDL Model of Argentina

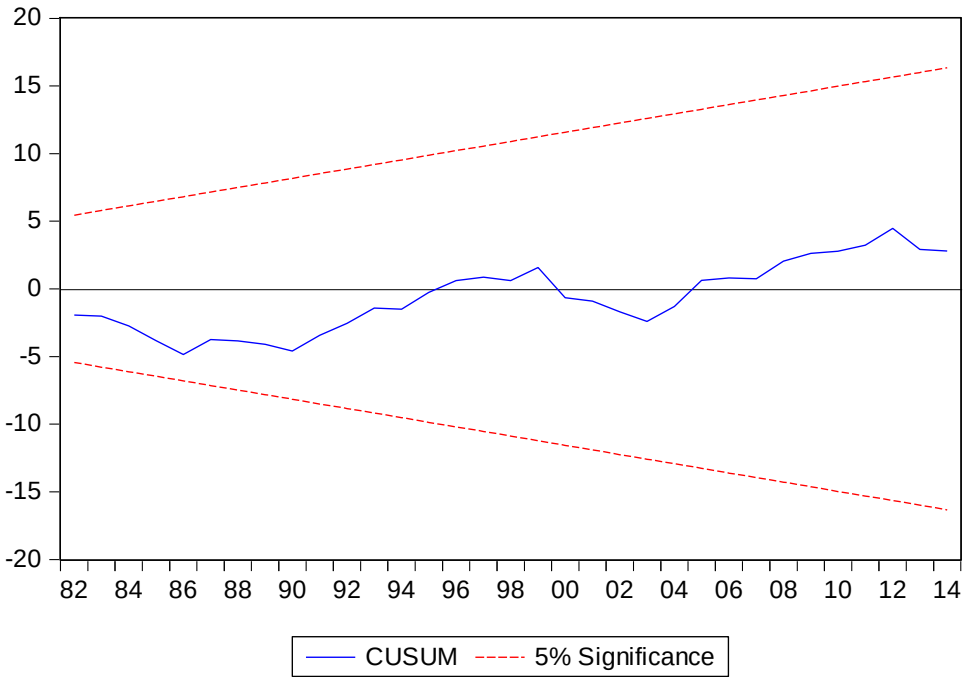

Figure 3: CSSM Test Results for NARDL Model of Argentina

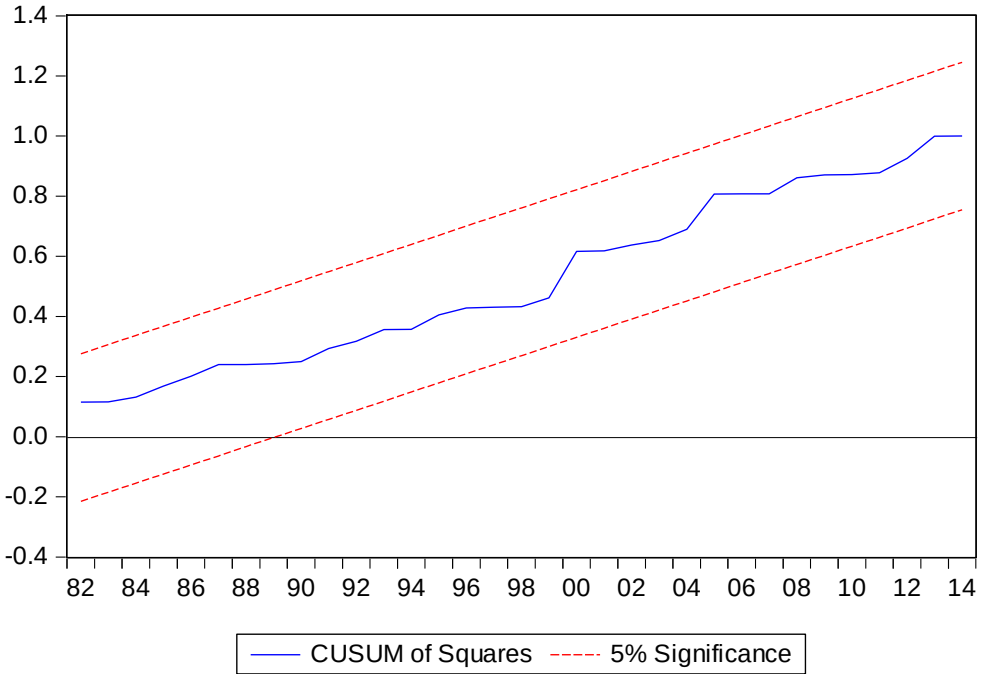

Figure 4: CSQM Test Results for NARDL Model of Argentina

3.1.3 Bootstrap ARDL Model for Argentina

Bootstrap ARDL model is applied to investigate the EKC relationship between variables which are CO2, GDP, SQ and ENC. According to test results, no EKC relationship is found since F test statistics value which is 2.565 is lower than critical value of 10% which is 3.484 (see Table 5).

The EKC relationship for Argentina is rejected by ARDL, NARDL and Bootstrap ARDL models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,565	5,991	4,391	3,484
Bootstrap P-Value	0,256		
% of Failed Iterations	2,90		

Table 5: PSS Bootstrap F-Test Based on ARDL Model for Argentina

3.2 Egypt

3.2.1 ARDL Model for Egypt

The EKC relationship is investigated between CO2, GDP, SQ and ENC by ARDL Model. According to unit root test results, the variables are at I(1) levels (see Table 6). Lag length is determined according to lag

length results in VAR model (see Table 7). According to ARDL bounds test results, there is no cointegration between the variables since F-statistics value which is 3.427991 is less than 3.69 which is I0 bound value of 2.5%. ARDL model is stable according to stability test results (see Table 8, Figure 5 and Figure 6).

	Level	First Difference
CO2	-2.017766	-7.416083 (1%)
GDP	-2.553432	-3.624684 (1%)
SQ	-2.246949	-3.695775 (1%)
ENC	-2.486051	-5.587300 (1%)

Table 6: UR Results for Egypt

Lag	LogL	LR	FPE	AIC	SC	HQ
0	142.8388	NA	1.14e-08	-6.941941	-6.773053	-6.880876
1	362.6861	384.7327	4.28e-13	-17.13430	-16.28986*	-16.82898*
2	379.8774	26.64660*	4.14e-13*	-17.19387*	-15.67388	-16.64429
3	392.2015	16.63745	5.31e-13	-17.01007	-14.81453	-16.21623
4	410.2491	20.75477	5.47e-13	-17.11246	-14.24136	-16.07436

Table 7: Lag Length Results for Egypt

	F-statistic	Jarque-Bera
RE Test	0.024178 (0.8774)	-
HE Test	1.735691 (0.1417)	-
CO Test	0.184517 (0.8324)	-
NO Test	-	3.431804 (0.179802)

Table 8: Stability Test Results for ARDL Model of Egypt

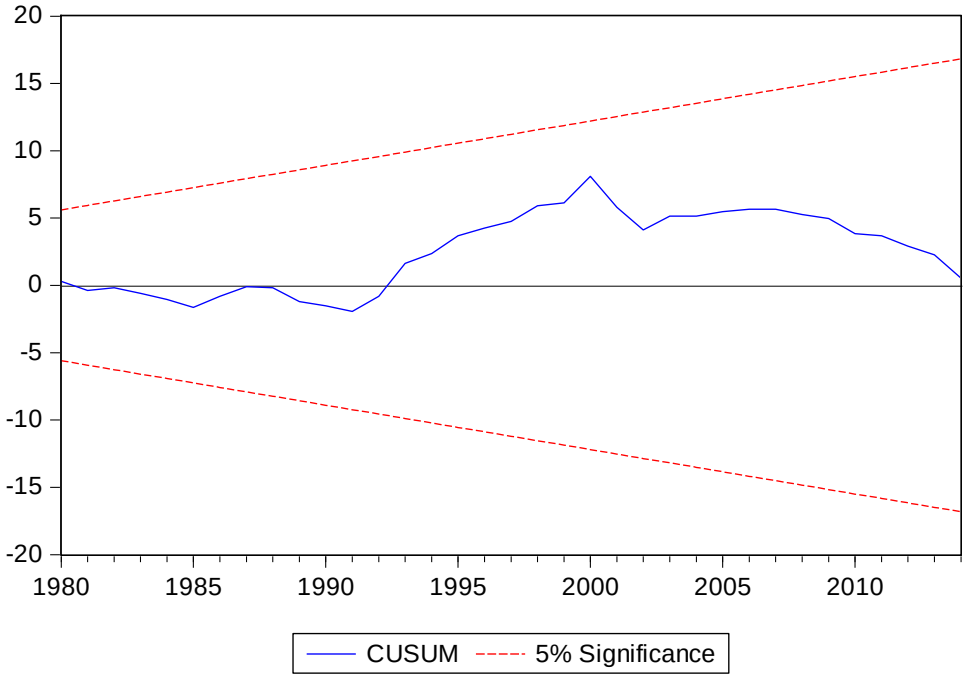

Figure 5: CSSM Test Results for ARDL Model of Egypt

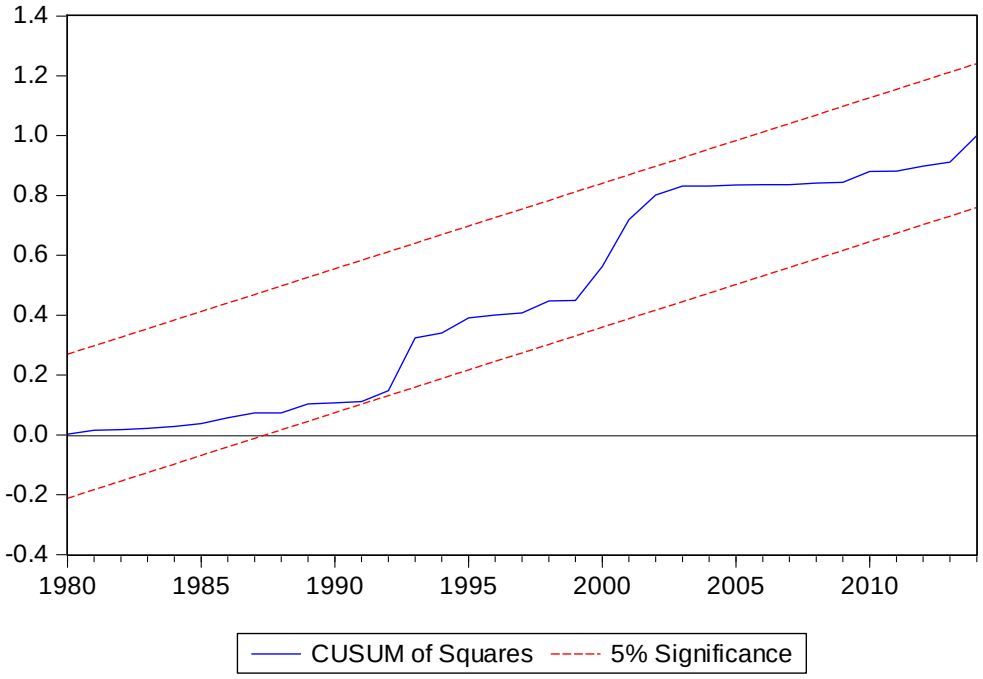

Figure 6: CSQM Test Results for ARDL Model of Egypt

3.2.2 NARDL Model for Egypt

The EKC relationship is investigated between CO2, GDP, SQ and ENC by NARDL model. According to test results, there is no cointegration between the variables, since F-statistics value which is 3.723612 is lower than 3.74 which is I0 value of 1%. NARDL model is stable according to stability test results (see Table 9, Figure 7 and Figure 8).

	F-statistic	Jarque-Bera
RE Test	0.000566 (0.9812)	-
HE Test	1.738281 (0.1330)	-
CO Test	0.796803 (0.4595)	-
NO Test	-	4.882616 (0.087047)

Table 9: Stability Test Results for NARDL Model of Egypt

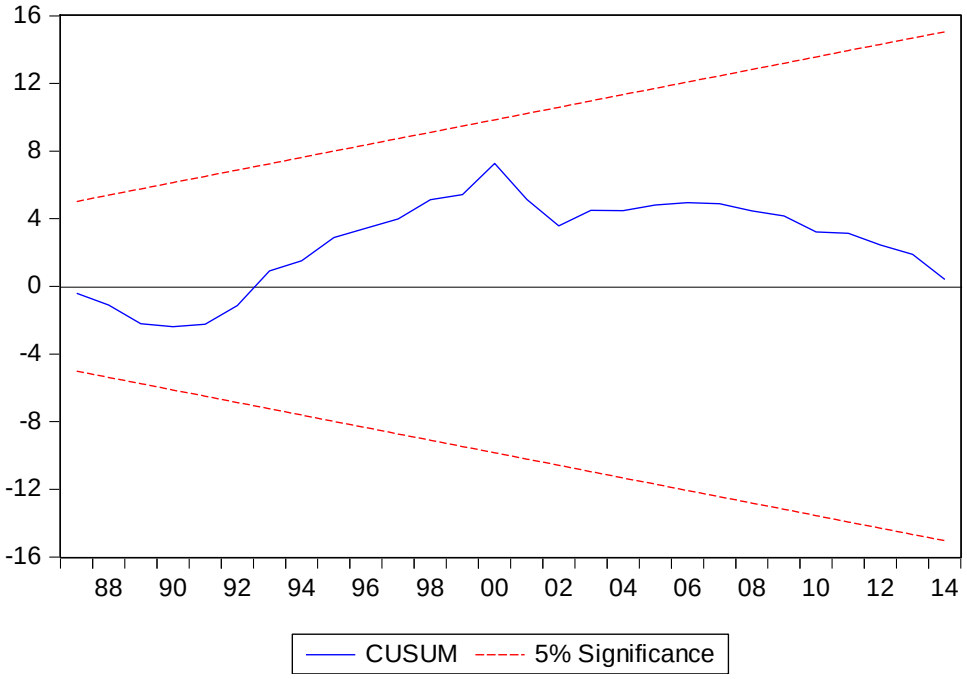

Figure 7: CSSM Test Results for NARDL Model of Egypt

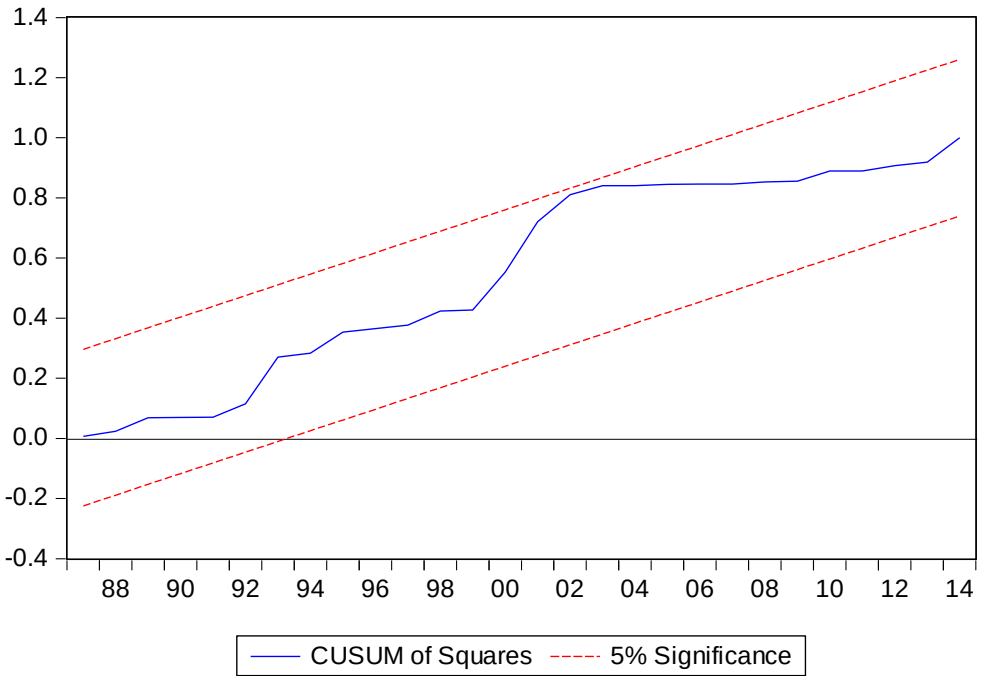

Figure 8: CSQM Test Results for NARDL Model of Egypt

3.2.3 Bootstrap ARDL Model for Egypt

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP, SQ and ENC. According to test results, there is no cointegration between the variables, since F-statistics value which is 2.056 is lower than critical value of 10% which is 4.610 (see Table 10).

The EKC relationship for Egypt is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,056	6,795	5,404	4,610
Bootstrap P-Value	0,643		
% of Failed Iterations	0,70		

Table 10: PSS Bootstrap F-Test Based on ARDL Model for Egypt

3.3 Ghana

3.3.1 ARDL Model for Ghana

According to unit root test results, variables are at I(1) level (see Table 11). Lag length is determined according to lag length results in VAR model (see Table 12). F-statistics value of ARDL bounds test is 1.971845 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC. ARDL model is stable according to stability test results (see Table 13, Figure 9 and Figure 10).

	Level	First Difference
CO2	-0.000784	-9.514818 (1%)
GDP	0.479792	-4.222747 (1%)
SQ	0.572594	-4.202418 (1%)
ENC	-1.614681	-5.961521 (1%)

Table 11: UR Results for Ghana

Lag	LogL	LR	FPE	AIC	SC	HQ
0	126.4014	NA	2.58e-08	-6.120068	-5.951180	-6.059003
1	281.1669	270.8397*	2.52e-11*	-13.05835	-12.21391*	-12.75302*
2	297.3188	25.03536	2.57e-11	-13.06594*	-11.54595	-12.51636
3	303.3179	8.098795	4.52e-11	-12.56589	-10.37035	-11.77205
4	325.4893	25.49717	3.79e-11	-12.87447	-10.00337	-11.83637

Table 12: Lag Length Results for Ghana

	F-statistic	Jarque-Bera
RE Test	0.363239 (0.5506)	-
HE Test	1.599466 (0.1852)	-
CO Test	0.783942 (0.4647)	-
NO Test	-	1.790396 (0.408527)

Table 13: Stability Test Results for ARDL Model of Ghana

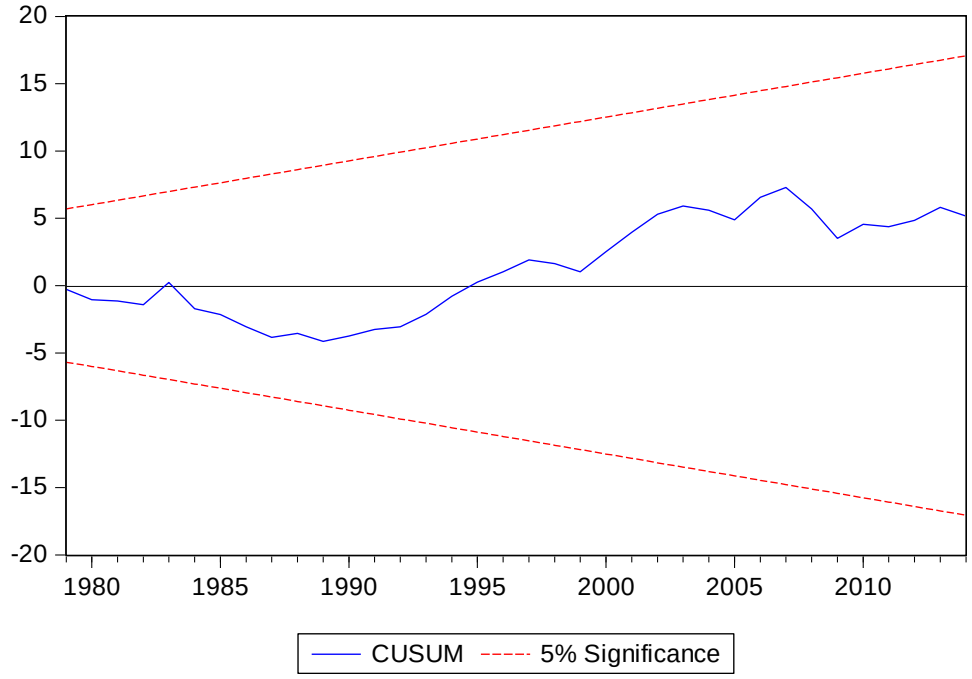

Figure 9: CSSM Test Results for ARDL Model of Ghana

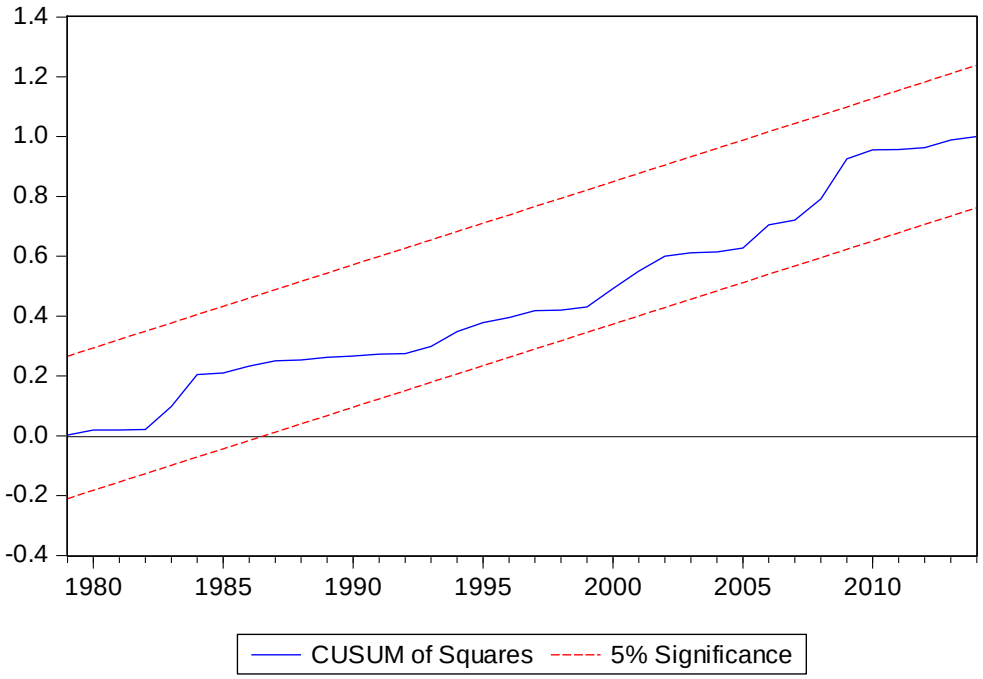

Figure 10: CSQM Test Results for ARDL Model of Ghana

3.3.2 NARDL Model for Ghana

EKC relationship is investigated between CO2, GDP, SQ and ENC. According to bounds test results, F-statistics value is 2.203590 which is less than 2.45 which is I0 bound value of 10%. NARDL model is stable

according to stability test results (see Table 14, Figure 11 and Figure 12).

	F-statistic	Jarque-Bera
RE Test	0.641680 (0.4304)	-
HE Test	0.873340 (0.5877)	-
CO Test	0.111625 (0.8948)	-
NO Test	-	0.134238 (0.935084)

Table 14: Stability Test Results for NARDL Model of Ghana

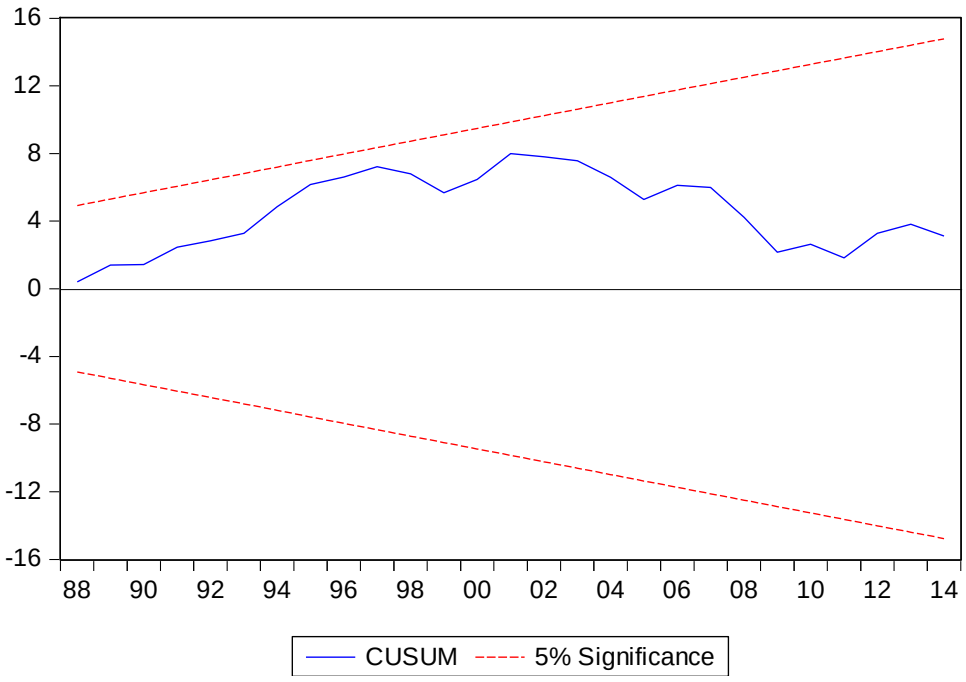

Figure 11: CSSM Test Results for NARDL Model of Ghana

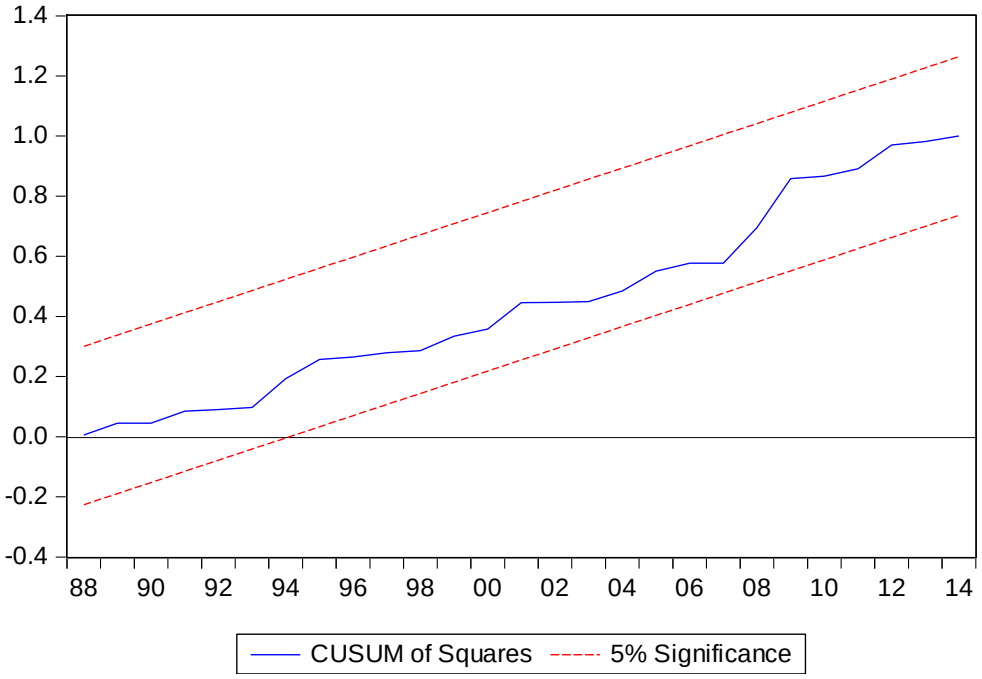

Figure 12: CSQM Test Results for NARDL Model of Ghana

3.3.3 Bootstrap ARDL Model for Ghana

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP, SQ and ENC. According to test results, there is no cointegration between the variables, since F-statistics value which is 0.683 is lower than critical value of 10% which is 3.647 (see Table 15).

EKC relationship for Ghana is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
0,683	5,710	4,455	3,647
Bootstrap P-Value	0,947		
% of Failed Iterations	3,60		

Table 15: PSS Bootstrap F-Test Based on ARDL Model for Ghana

3.4 Iran

3.4.1 ARDL Model for Iran

F-statistics value of ARDL bounds test is 1.715465 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC. ARDL model is stable according to stability test results.

	Level	First Difference
CO2	-0.257043	-5.177741 (1%)
GDP	-1.929386	-4.109133 (1%)
SQ	-1.950584	-4.085889 (1%)
ENC	-2.123782	-8.339386 (1%)

Table 16: UR Results for Iran

Lag	LogL	LR	FPE	AIC	SC	HQ
0	96.60388	NA	1.15e-07	-4.630194	-4.461306	-4.569130
1	244.3553	258.5649	1.59e-10	-11.21776	-10.37332*	-10.91244
2	267.9029	36.49876	1.12e-10	-11.59514	-10.07515	-11.04556*
3	281.7292	18.66551	1.33e-10	-11.48646	-9.290915	-10.69262
4	305.9535	27.85798*	1.01e-10*	-11.89767*	-9.026580	-10.85958

Table 17: Lag Length Results for Iran

	F-statistic	Jarque-Bera
RE Test	2.964937 (0.0991)	-
HE Test	0.533684 (0.9005)	-
CO Test	0.276016 (0.8898)	-
NO Test	-	3.549376 (0.169536)

Table 18: Stability Test Results for ARDL Model of Iran

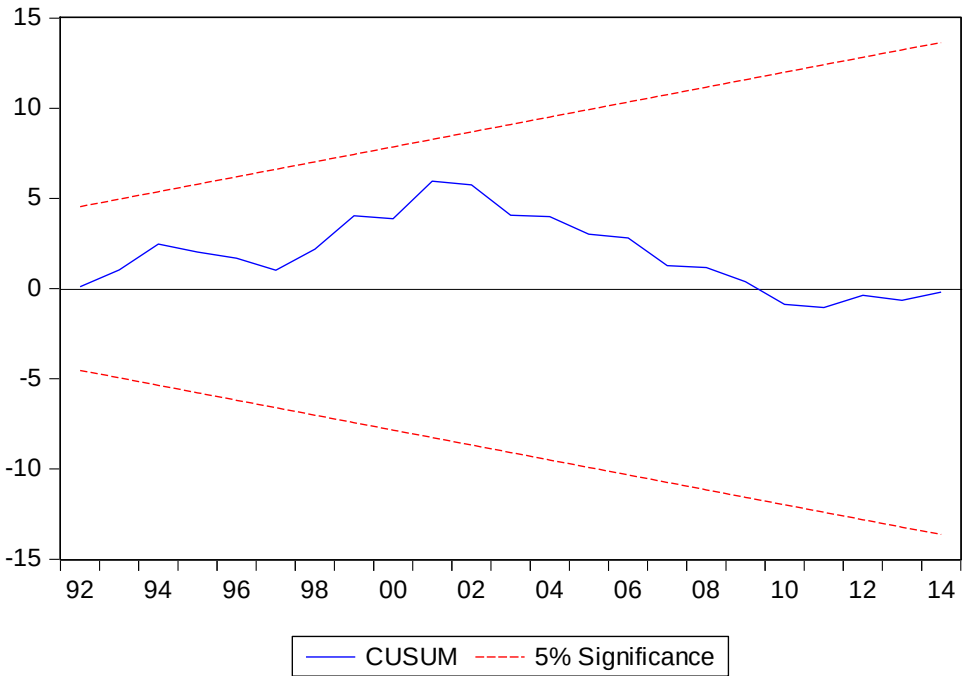

Figure 13: CSSM Test Results for ARDL Model of Iran

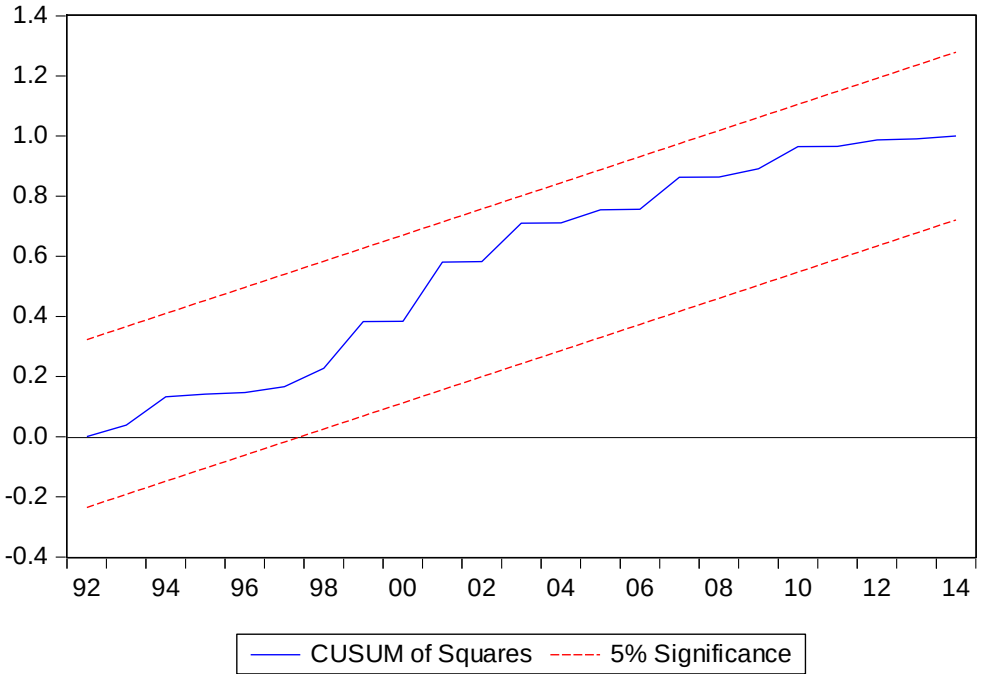

Figure 14: CSQM Test Results for ARDL Model of Iran

3.4.2 NARDL Model for Iran

EKC relationship is investigated between CO2, GDP, SQ and ENC. F-statistics value of NARDL bounds test is 3.434408 which is less than 3.74 which is I0 bound value of 1%. No cointegration is found between the variables. NARDL model is stable according to stability test results (see Table 19, Figure 15 and Figure 16).

	F-statistic	Jarque-Bera
RE Test	0.015553 (0.9020)	-
HE Test	0.981807 (0.5112)	-
CO Test	0.761533 (0.5645)	-
NO Test	-	1.769052 (0.412910)

Table 19: Stability Test Results for NARDL Model of Iran

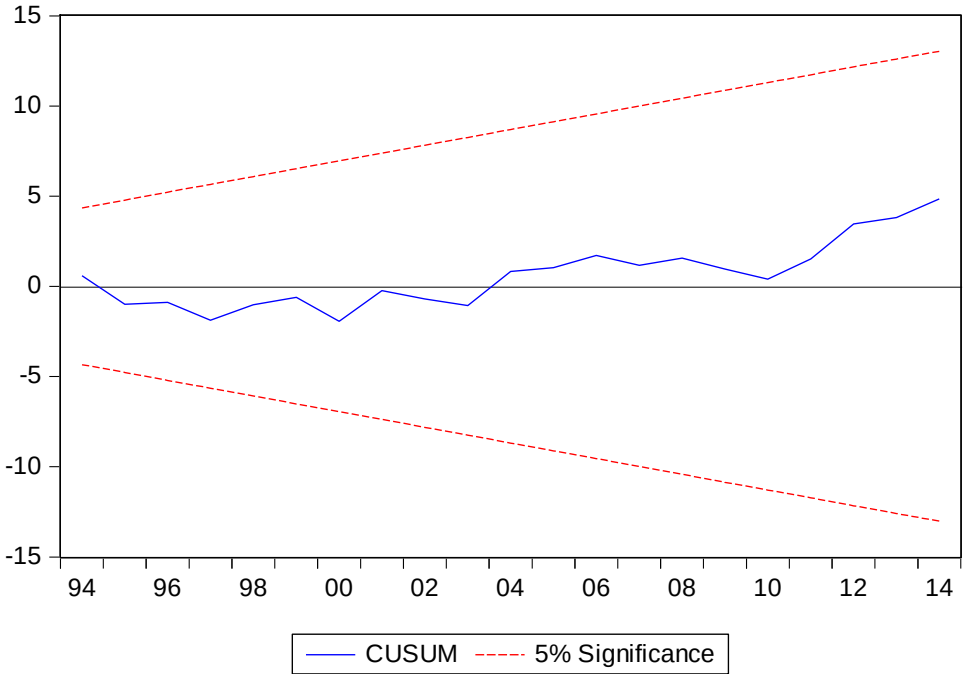

Figure 15: CSSM Test Results for NARDL Model of Iran

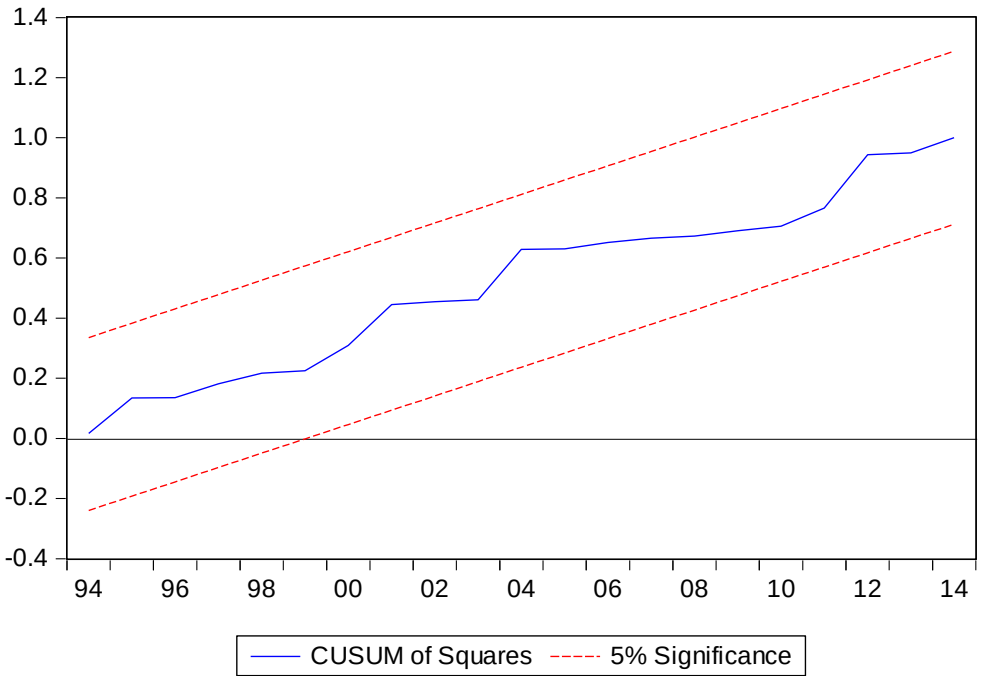

Figure 16: CSQM Test Results for NARDL Model of Iran

3.4.3 Bootstrap ARDL Model for Iran

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP, SQ and ENC. F-statistics value of bootstrap bounds test is 2.538 which is less than 3.808 which is the critical value of 10% (see Table 20).

EKC relationship for Ghana is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,538	6,777	4,408	3,808
Bootstrap P-Value	0,299		
% of Failed Iterations	1,70		

Table 20: PSS Bootstrap F-Test Based on ARDL Model for Iran

3.5 Kenya

3.5.1 ARDL Model for Kenya

F-statistics value of ARDL bounds test is 1.807908 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC. ARDL model is stable according to stability test results (see Table 23, Figure 17 and Figure 18).

	Level	First Difference
CO2	-2.190654	-6.641608 (1%)
GDP	-0.056672	-5.677609 (1%)
GDP2	-0.029963	-5.584770 (1%)
ENC	0.258768	-3.588524 (5%)

Table 21: UR Results for Kenya

Lag	LogL	LR	FPE	AIC	SC	HQ
0	310.5704	NA	2.59e-12	-15.32852	-15.15963	-15.26746
1	432.1279	212.7256*	1.33e-14*	-20.60639*	-19.76195*	-20.30107*
2	443.0417	16.91647	1.76e-14	-20.35209	-18.83210	-19.80251
3	453.4026	13.98718	2.49e-14	-20.07013	-17.87459	-19.27629
4	473.7524	23.40225	2.29e-14	-20.28762	-17.41652	-19.24952

Table 22: Lag Length Results for Kenya

	F-statistic	Jarque-Bera
RE Test	0.320785 (0.5746)	-
HE Test	0.873630 (0.4887)	-
CO Test	0.012183 (0.9127)	-
NO Test	-	1.431609 (0.488799)

Table 23: Stability Test Results for ARDL Model of Kenya

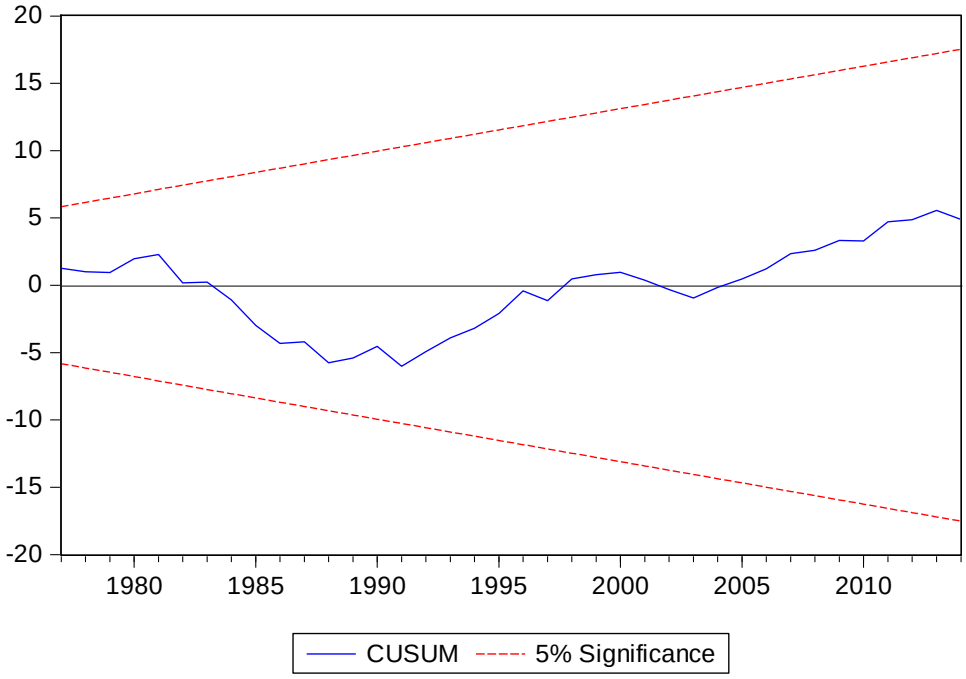

Figure 17: CSSM Test Results for ARDL Model of Kenya

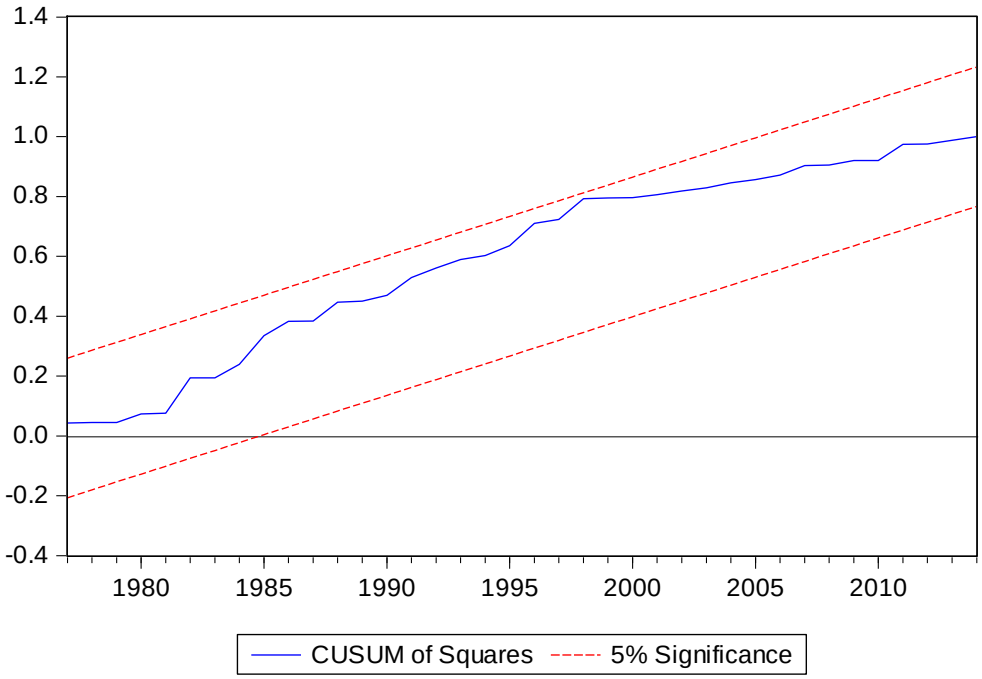

Figure 18: CSQM Test Results for ARDL Model of Kenya

3.5.2 NARDL Model for Kenya

EKC relationship is investigated between CO2, GDP, SQ and ENC. F-statistics value of NARDL bounds test is 1.522903 which is less than 2.45 which is I0 bound value of 10%. No cointegration is found between the variables. NARDL model is stable according to stability test results (see Table 24, Figure 19 and Figure 20).

	F-statistic	Jarque-Bera
RE Test	0.464467 (0.4999)	-
HE Test	1.501382 (0.2131)	-
CO Test	0.332723 (0.5676)	-
NO Test	-	0.580353 (0.748131)

Table 24: Stability Test Results for NARDL Model of Kenya

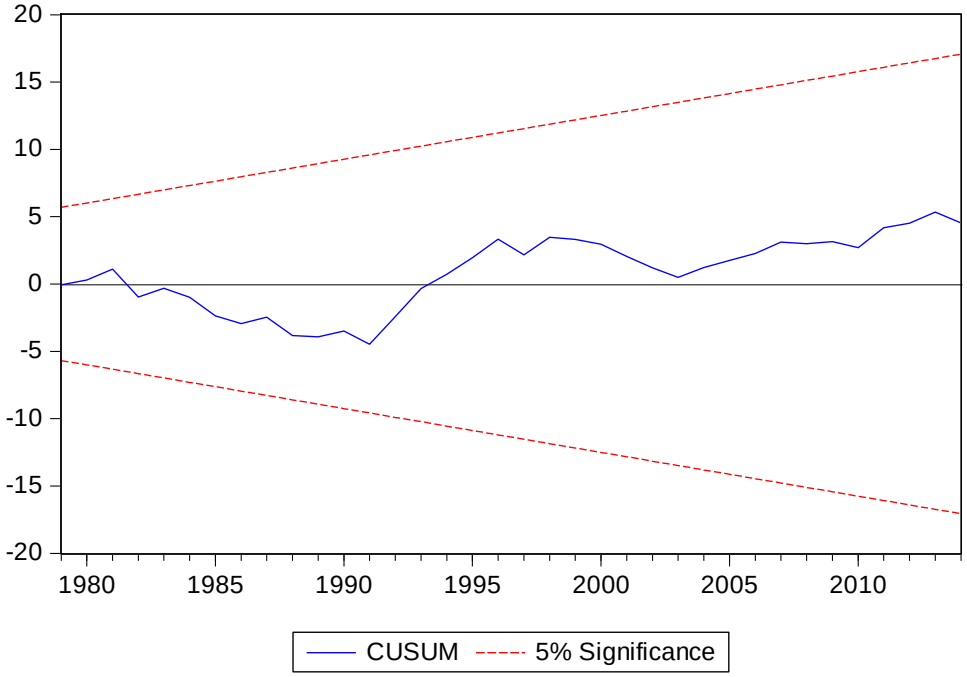

Figure 19: CSSM Test Results for NARDL Model of Kenya

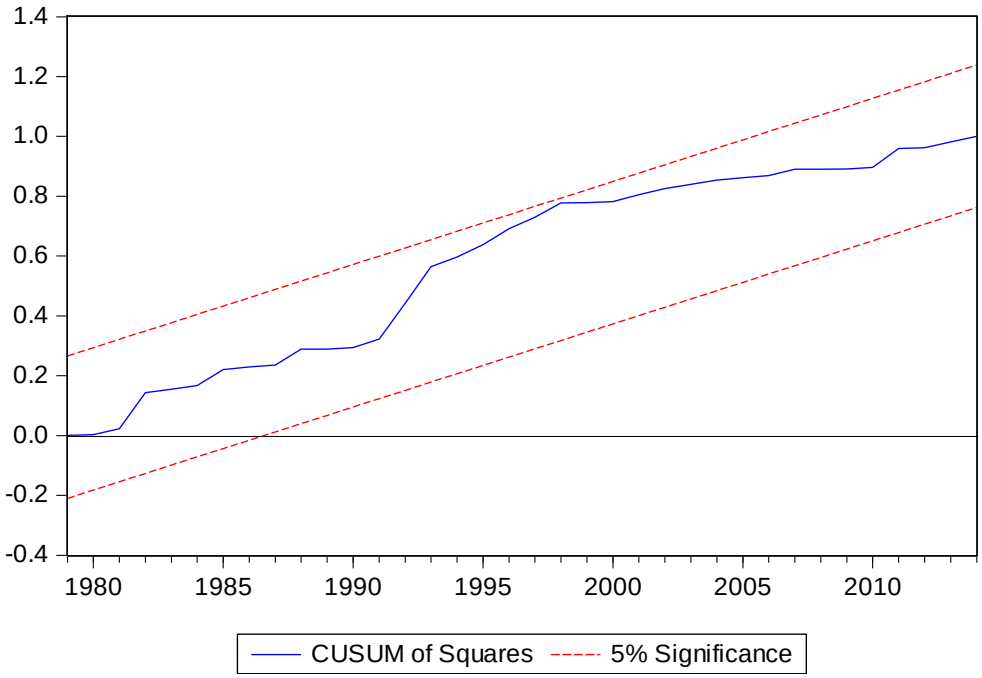

Figure 20: CSQM Test Results for NARDL Model of Kenya

3.5.3 Bootstrap ARDL Model for Kenya

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP, SQ and ENC. F-statistics value of bootstrap bounds test is 1.039 which is less than 3.017 which is the critical value of 10% (see Table 25).

EKC relationship for Kenya is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
1,039	4,573	3,565	3,017
Bootstrap P-Value	0,732		
% of Failed Iterations	5,01		

Table 25: PSS Bootstrap F-Test Based on ARDL Model for Kenya

3.6 Malaysia

3.6.1 ARDL Model for Malaysia

F-statistics value of ARDL bounds test is 2.123685 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC. ARDL model is stable according to stability test results (see Table 28, Figure 21 and Figure 22).

	Level	First Difference
CO2	-0.812087	-7.925199 (1%)
GDP	-1.609171	-5.623014 (1%)
SQ	-1.202713	-5.735102 (1%)
ENC	-1.100023	-6.933648 (1%)

Table 26: UR Results for Malaysia

Lag	LogL	LR	FPE	AIC	SC	HQ
0	107.7948	NA	6.55e-08	-5.189738	-5.020850	-5.128674
1	290.6584	320.0113*	1.57e-11*	-13.53292*	-12.68848*	-13.22760*
2	301.6118	16.97788	2.07e-11	-13.28059	-11.76060	-12.73101
3	310.7440	12.32840	3.12e-11	-12.93720	-10.74166	-12.14336
4	321.7938	12.70732	4.56e-11	-12.68969	-9.818597	-11.65159

Table 27: Lag Length Results for Malaysia

	F-statistic	Jarque-Bera
RE Test	0.316377 (0.5774)	-
HE Test	0.958484 (0.4667)	-
CO Test	0.953823 (0.3355)	-
NO Test	-	4.696089 (0.095556

Table 28: Stability Test Results for ARDL Model of Malaysia

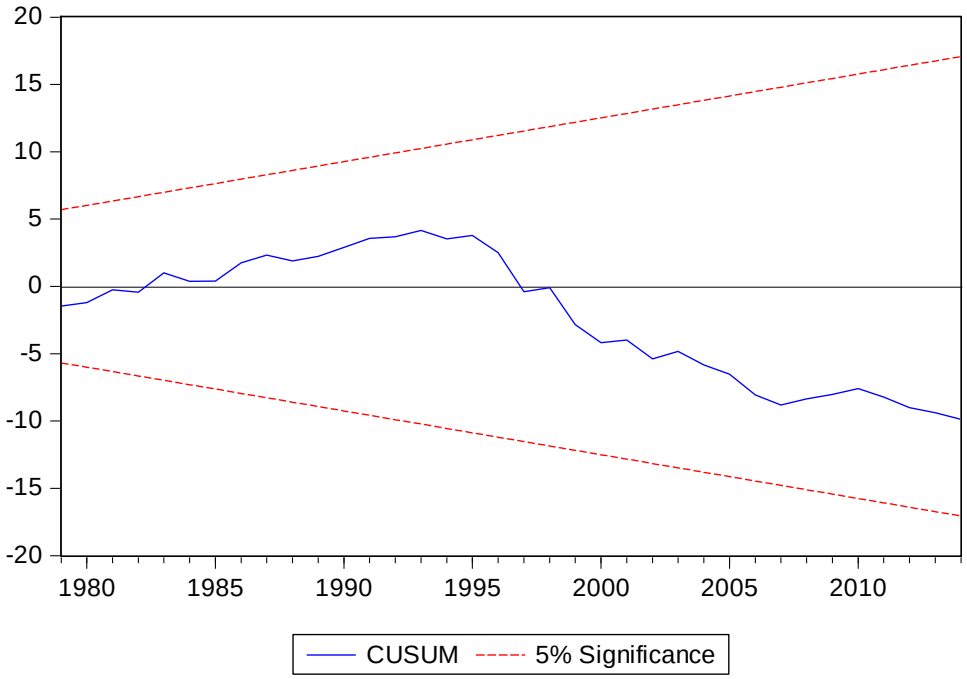

Figure 21: CSSM Test Results for ARDL Model of Malaysia

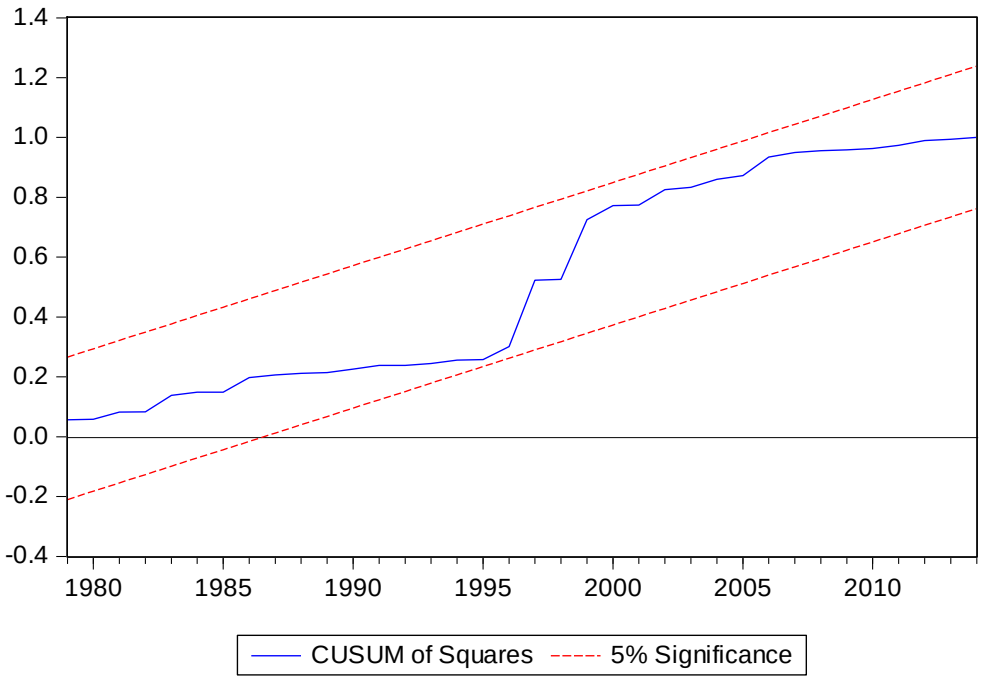

Figure 22: CSQM Test Results for ARDL Model of Malaysia

3.6.2 NARDL Model for Malaysia

The EKC relationship is investigated between CO2, GDP, SQ and ENC. F-statistics value of NARDL bounds test is 2.433700 which is less than 2.45 which is I0 bound value of 10%. No cointegration is found between the variables. NARDL model is stable according to stability test results (see Table 29, Figure 23 and Figure 24).

	F-statistic	Jarque-Bera
RE Test	0.106370 (0.7464)	-
HE Test	0.755498 (0.6277)	-
CO Test	0.149734 (0.7013)	-
NO Test	-	2.982530 (0.225088)

Table 29: Stability Test Results for NARDL Model of Malaysia

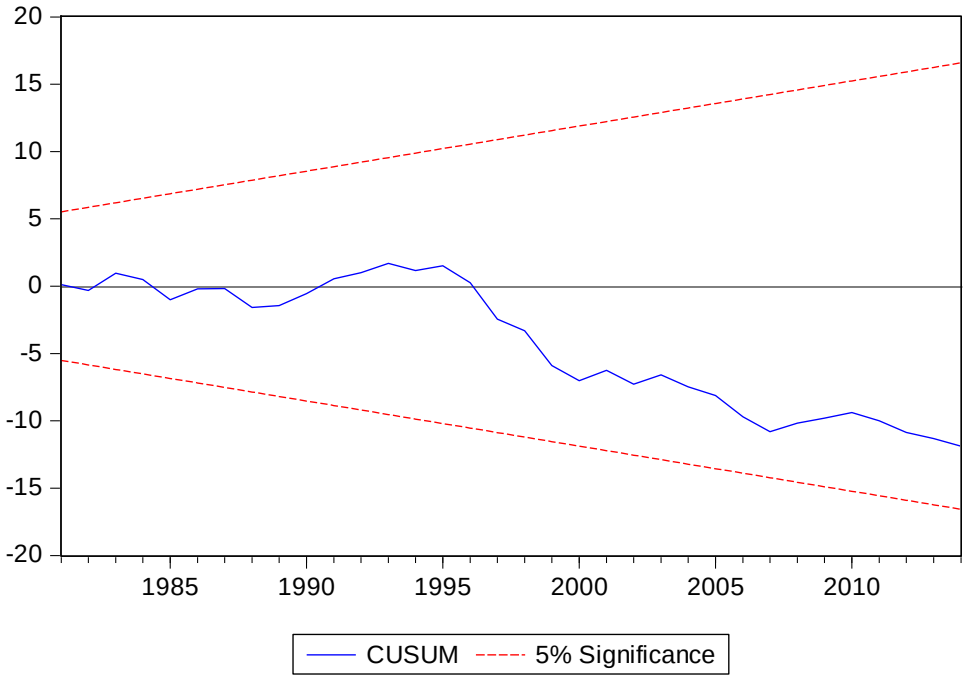

Figure 23: CSSM Test Results for NARDL Model of Malaysia

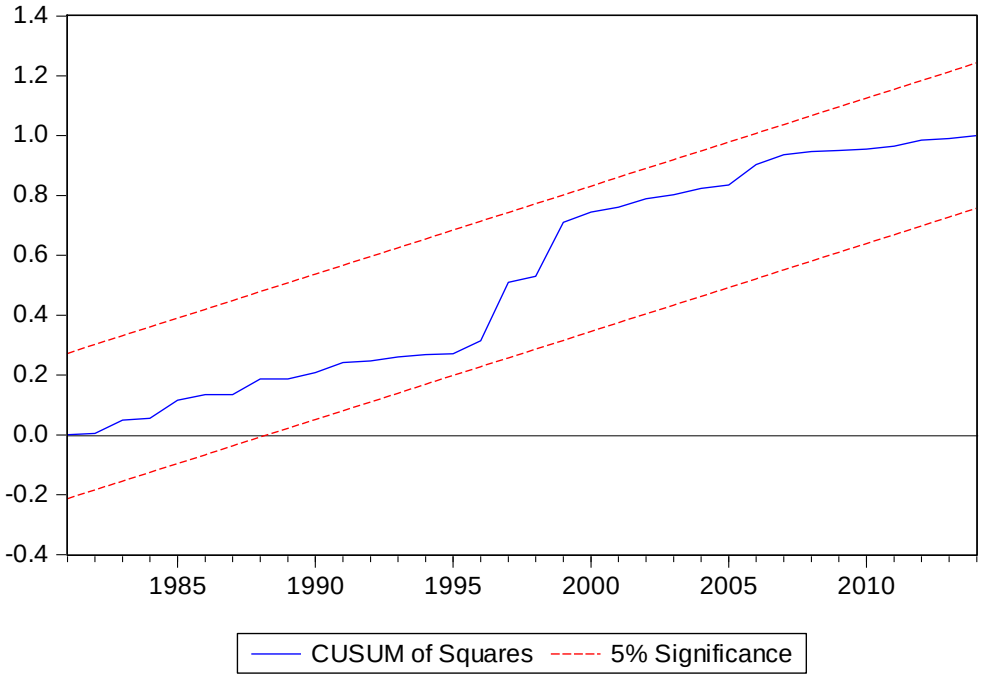

Figure 24: CSQM Test Results for NARDL Model of Malaysia

3.6.3 Bootstrap ARDL Model for Malaysia

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP, SQ and ENC. F-statistics value of bootstrap bounds test is 1.734 which is less than 3.549 which is the critical value of 10% (see Table 30).

The EKC relationship for Malaysia is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
1,734	5,835	4,158	3,549
Bootstrap P-Value	0,634		
% of Failed Iterations	0,40		

Table 30: PSS Bootstrap F-Test Based on ARDL Model for Malaysia

3.7 Nigeria

3.7.1 ARDL Model for Nigeria

F-statistics value of ARDL bounds test is 2.514236 which is less than 3.17 which is I0 bound value of 10%. No cointegration is found between CO2, GDP and SQ. ARDL model is stable according to stability test results (see Table 33, Figure 25 and Figure 26).

	Level	First Difference
CO2	-1.842214	-6.859844 (1%)
GDP	-0.043059	-5.388869 (1%)
SQ	0.007482	-5.409939 (1%)

Table 31: UR Results for Nigeria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	66.52077	NA	8.38e-06	-3.176038	-3.049373	-3.130240
1	164.9171	177.1134*	9.61e-08*	-7.645856*	-7.139192*	-7.462662*
2	170.6500	9.459327	1.14e-07	-7.482502	-6.595840	-7.161913
3	173.0940	3.665988	1.62e-07	-7.154702	-5.888042	-6.696718
4	180.8384	10.45489	1.80e-07	-7.091920	-5.445262	-6.496540

Table 32: Lag Length Results for Nigeria

	F-statistic	Jarque-Bera
RE Test	0.565077 (0.4569)	-
HE Test	0.908781 (0.4456)	-
CO Test	0.075168 (0.7854)	-
NO Test	-	3.578386 (0.167095)

Table 33: Stability Test Results for ARDL Model of Nigeria

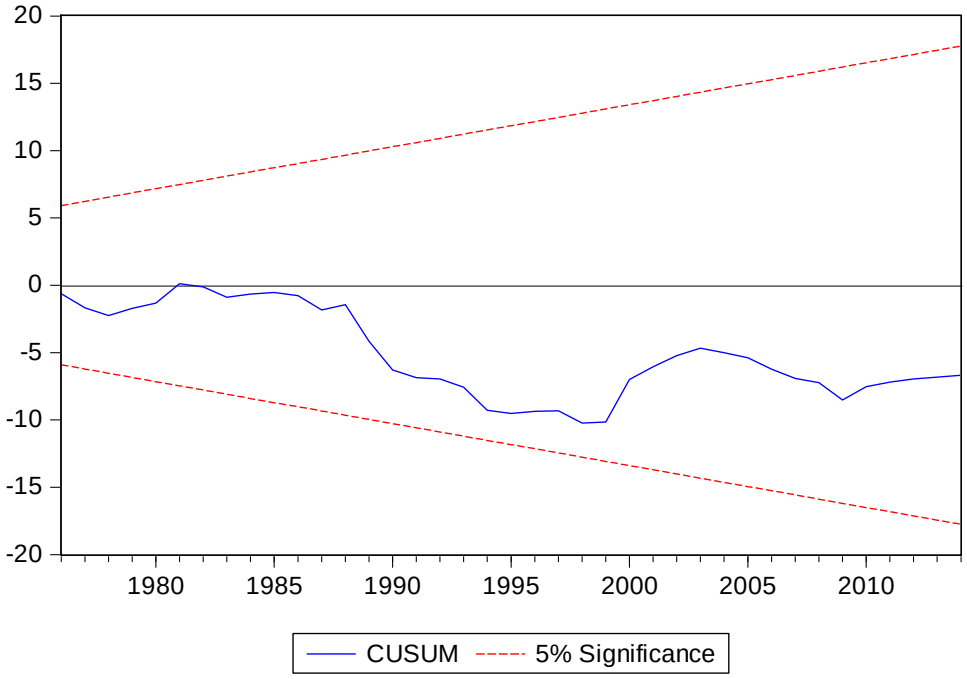

Figure 25: CSSM Test Results for ARDL Model of Nigeria

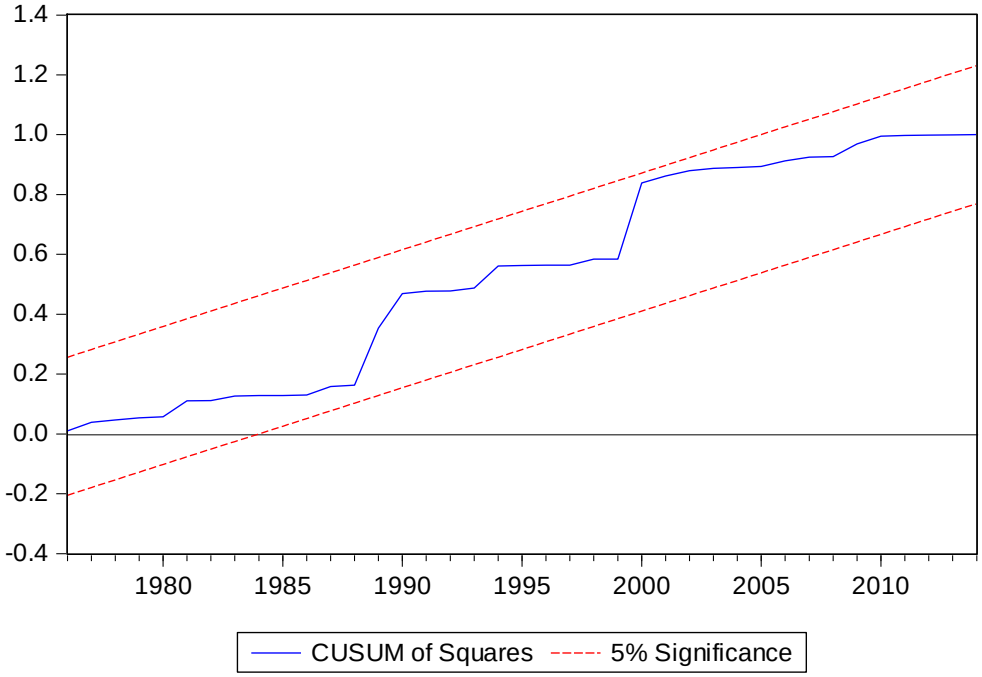

Figure 26: CSQM Test Results for ARDL Model of Nigeria

3.7.2 NARDL Model for Nigeria

EKC relationship is investigated between CO2, GDP and SQ. F-statistics value of NARDL bounds test is 1.752091 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between the variables. NARDL model is stable according to stability test results (see Table 34, Figure 27 and Figure 28).

	F-statistic	Jarque-Bera
RE Test	1.366422 (0.2499)	-
HE Test	0.972247 (0.4340)	-
CO Test	0.129758 (0.7207)	-
NO Test	-	3.816231 (0.148360)

Table 34: Stability Test Results for NARDL Model of Nigeria

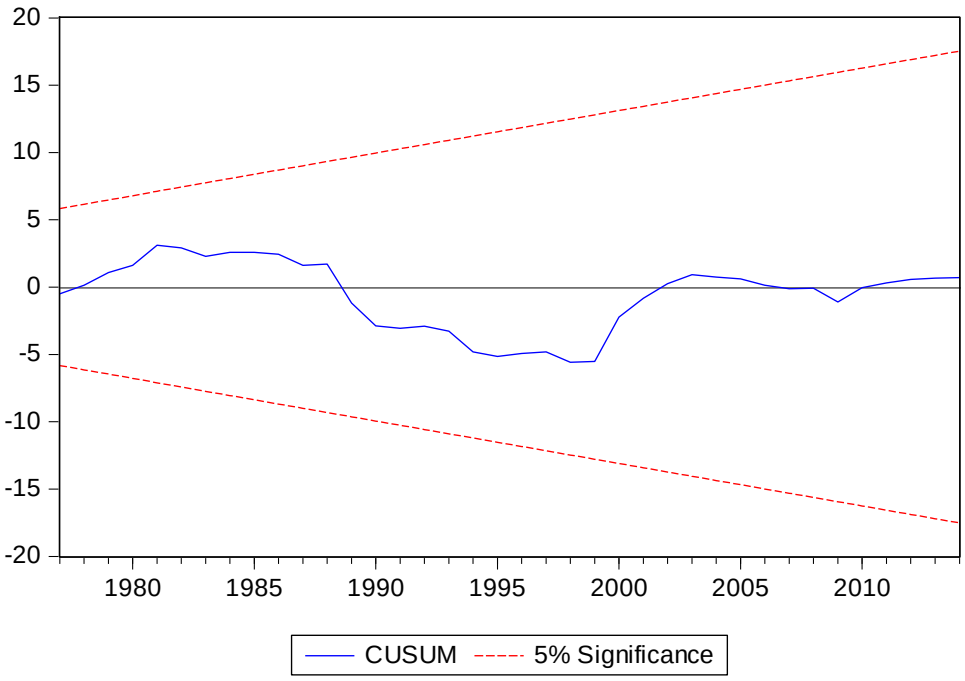

Figure 27: CSSM Test Results for NARDL Model of Nigeria

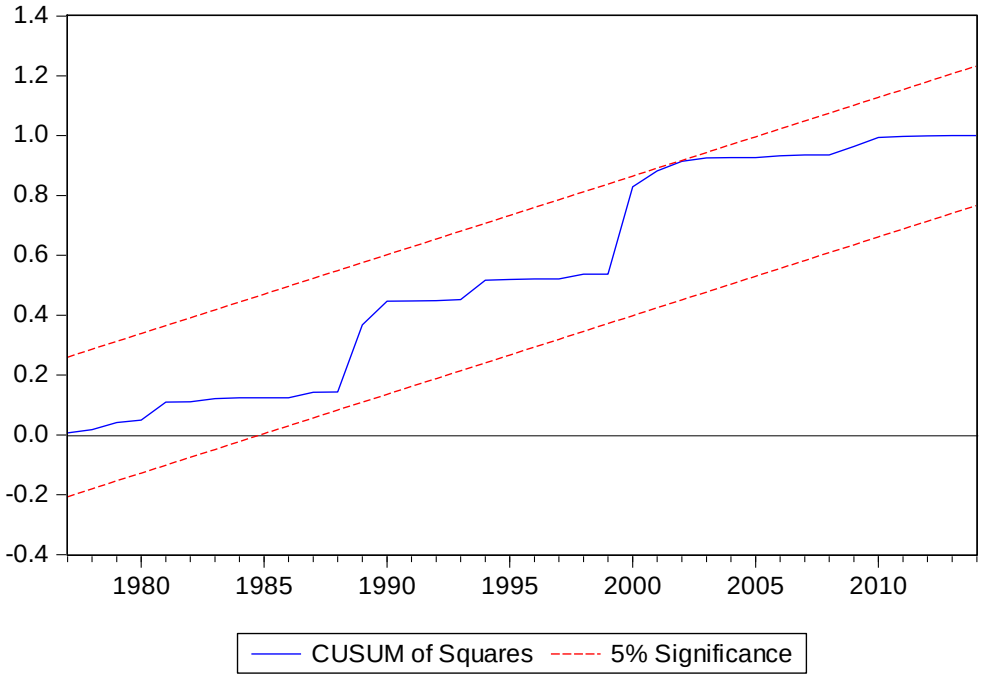

Figure 28: CSQM Test Results for NARDL Model of Nigeria

3.7.3 Bootstrap ARDL Model for Nigeria

Bootstrap ARDL bounds test is applied to investigate the relationship between CO2, GDP and SQ. F-statistics value of bootstrap bounds test is 2.943 which is less than 4.084 which is the critical value of 10% (see Table 35).

EKC relationship for Nigeria is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1971 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,943	6,799	4,701	4,084
Bootstrap P-Value	0,273		
% of Failed Iterations	0,30		

Table 35: PSS Bootstrap F-Test Based on ARDL Model for Nigeria

CHAPTER 4
EKC FOR DEVELOPED COUNTRIES

EKC hypothesis is tested for Austria, Belgium, Sweden and Finland. CO2-GDP-SQ nexus is examined for Austria and Belgium. CO2-GDP-SQ-ENC nexus is examined for Sweden and Finland. ARDL, NARDL, bootstrap ARDL models are used for Austria, Belgium and Sweden. Bootstrap ARDL model is used for Finland.

4.1 Austria

4.1.1 ARDL Model for Austria

CO2, GDP and SQ are at I(0) level according to unit root test results (see Table 36). Lag length is determined according to results in VAR model (see Table 37). F-statistics value of bounds cointegration test is 3.416260 which is less than 3.79 which is I0 bound value of 5%. No cointegration is found between the variables. The model is stable according to the stability test results (see Table 38, Figure 29 and Figure 30).

	Level	First Difference
CO2	-3.133450 (5%)	-
GDP	-4.903690 (1%)	-
SQ	-4.436952 (1%)	-

Table 36: UR Results for Austria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	86.53999	NA	7.58e-06	-3.276078	-3.162441	-3.232654
1	382.7950	546.0386*	9.73e-11*	-14.54098*	-14.08643*	-14.36728*
2	390.0355	12.49355	1.05e-10	-14.47198	-13.67652	-14.16801
3	397.1514	11.44119	1.14e-10	-14.39809	-13.26173	-13.96385
4	401.7567	6.862818	1.38e-10	-14.22575	-12.74848	-13.66124

Table 37: Lag Length Results for Austria

	F-statistic	Jarque-Bera
RE Test	0.247251 (0.6213)	-
HE Test	1.486298 (0.2208)	-
CO Test	2.280692 (0.1375)	-
NO Test	-	0.785855 (0.675078)

Table 38: Stability Test Results for ARDL Model of Austria

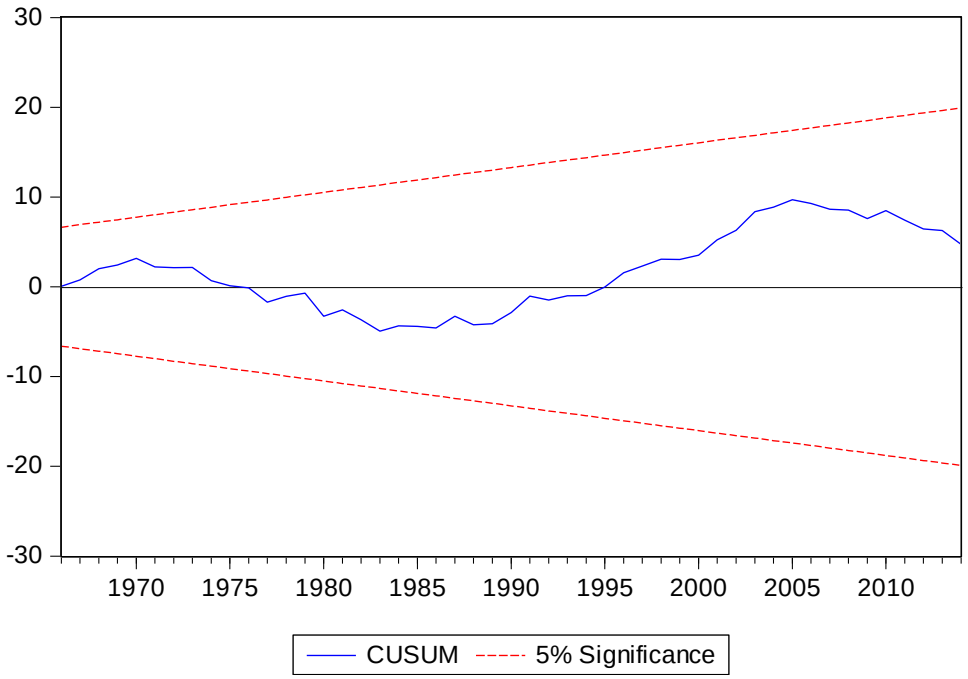

Figure 29: CSSM Test Results for ARDL Model of Austria

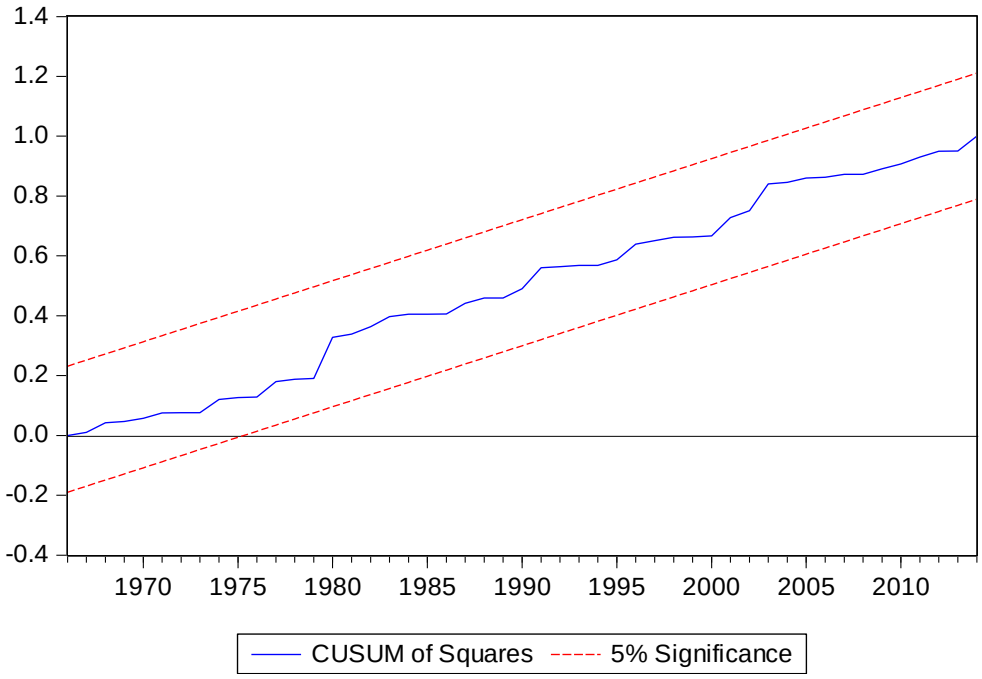

Figure 30: CSQM Test Results for ARDL Model of Austria

4.1.2 NARDL Model for Austria

F-statistics value of bounds cointegration test is 3.414855 which is less than 3.69 which is I0 bound value of 2.5%. No cointegration is found between CO2, GDP and SQ. NARDL model is stable according to the stability test results (see Table 39, Figure 31 and Figure 32).

	F-statistic	Jarque-Bera
RE Test	3.455631 (0.0693)	-
HE Test	1.289953 (0.2839)	-
CO Test	1.907379 (0.1738)	-
NO Test	-	0.491049 (0.782294)

Table 39: Stability Test Results for NARDL Model of Austria

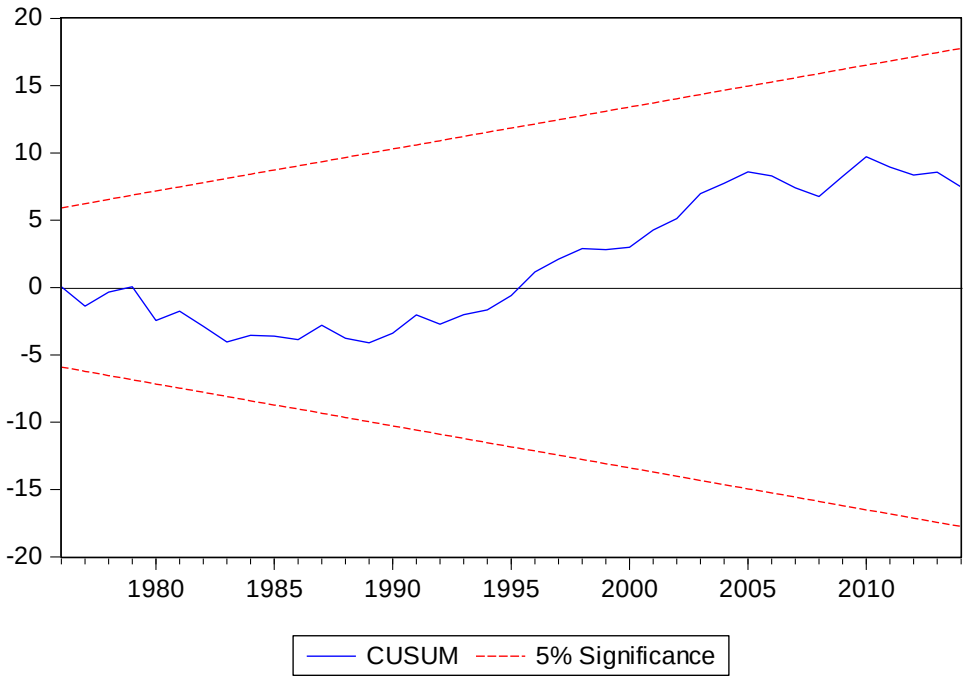

Figure 31: CSSM Test Results for NARDL Model of Austria

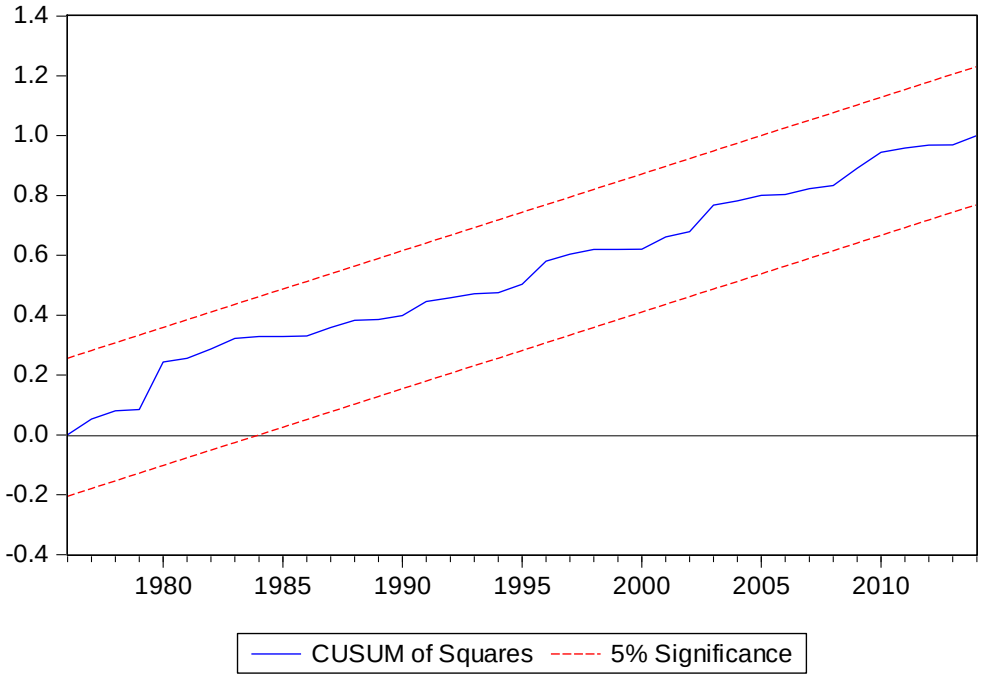

Figure 32: CSQM Test Results for NARDL Model of Austria

4.1.3 Bootstrap ARDL Model for Austria

Bootstrap ARDL bounds test is applied to analyze the cointegration between CO2, GDP and SQ. F-statistics value of bounds cointegration test is 1,326 which is less than 4,352 which is the critical value of 10% (see Table 40). No cointegration is found between the variables.

The EKC relationship for Austria is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1960 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
1,326	6,801	5,113	4,352
Bootstrap P-Value	0,916		
% of Failed Iterations	0,30		

Table 40: PSS Bootstrap F-Test Based on ARDL Model for Austria

4.2 Belgium

4.2.1 ARDL Model for Belgium

CO2, GDP and SQ are at I(0) level according to unit root test results (see Table 41). Lag length is determined according to results in VAR model (see Table 42). F-statistics value of bounds cointegration test is

2.391979 which is less than 3.17 which is I0 bound value of 10%. No cointegration is found between the variables. The model is stable according to the stability test results (see Table 43, Figure 33 and Figure 34).

	Level	First Difference
CO2	-3.133450 (5%)	-
GDP	-4.903690 (1%)	-
SQ	-4.436952 (1%)	-

Table 41: UR Results for Belgium

Lag	LogL	LR	FPE	AIC	SC	HQ
0	86.53999	NA	7.58e-06	-3.276078	-3.162441	-3.232654
1	382.7950	546.0386*	9.73e-11*	-14.54098*	-14.08643*	-14.36728*
2	390.0355	12.49355	1.05e-10	-14.47198	-13.67652	-14.16801
3	397.1514	11.44119	1.14e-10	-14.39809	-13.26173	-13.96385
4	401.7567	6.862818	1.38e-10	-14.22575	-12.74848	-13.66124

Table 42: Lag Length Results for Belgium

	F-statistic	Jarque-Bera
RE Test	0.247251 (0.6213)	-
HE Test	1.486298 (0.2208)	-
CO Test	2.280692 (0.1375)	-
NO Test	-	0.785855 (0.675078)

Table 43: Stability Test Results for ARDL Model of Belgium

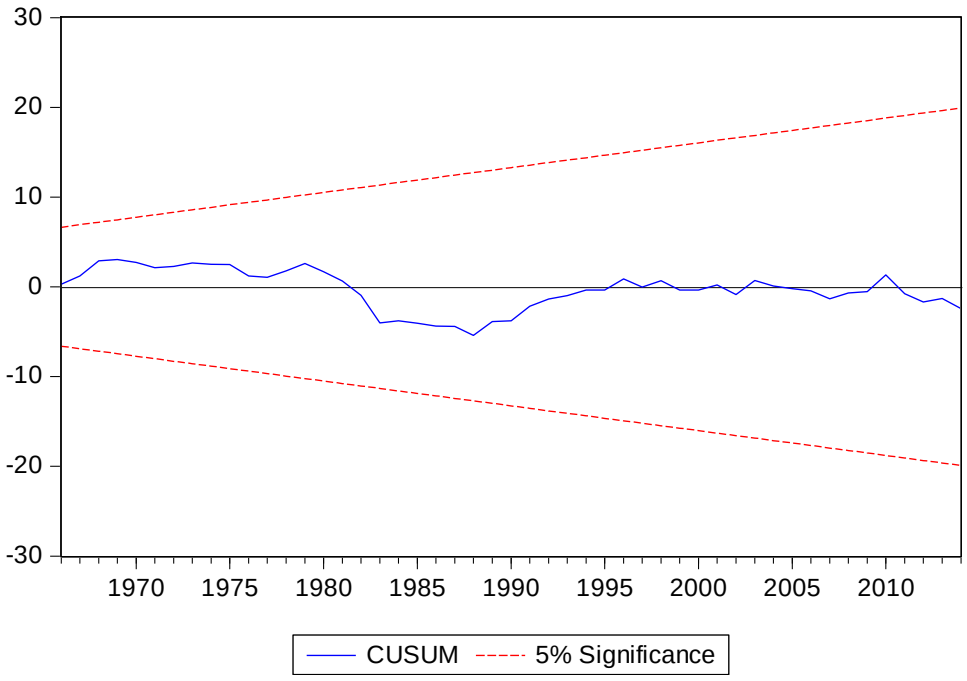

Figure 33: CSSM Test Results for ARDL Model of Belgium

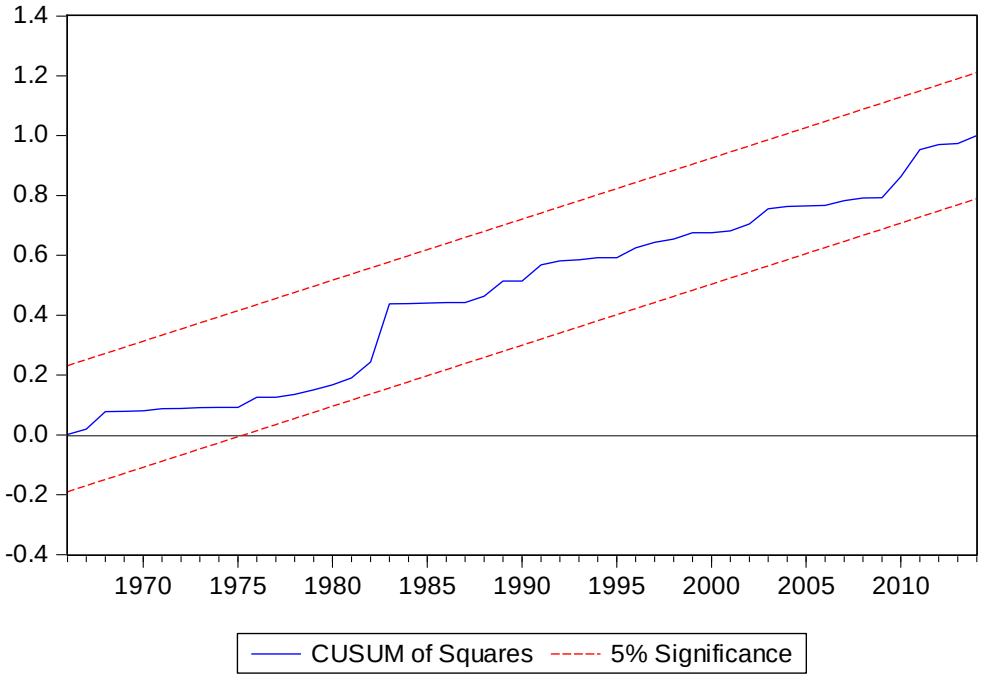

Figure 34: CSQM Test Results for ARDL Model of Belgium

4.2.2 NARDL Model for Belgium

F-statistics value of bounds cointegration test is 3.414855 which is less than 3.69 which is I0 bound value of 2.5%. No cointegration is found between CO2, GDP and SQ. NARDL model is stable according to the stability test results (see Table 44, Figure 35 and Figure 36).

	F-statistic	Jarque-Bera
RE Test	0.584362 (0.4484)	-
HE Test	0.523887 (0.7570)	-
CO Test	0.932986 (0.3390)	-
NO Test	-	0.277080 (0.870628)

Table 44: Stability Test Results for NARDL Model of Belgium

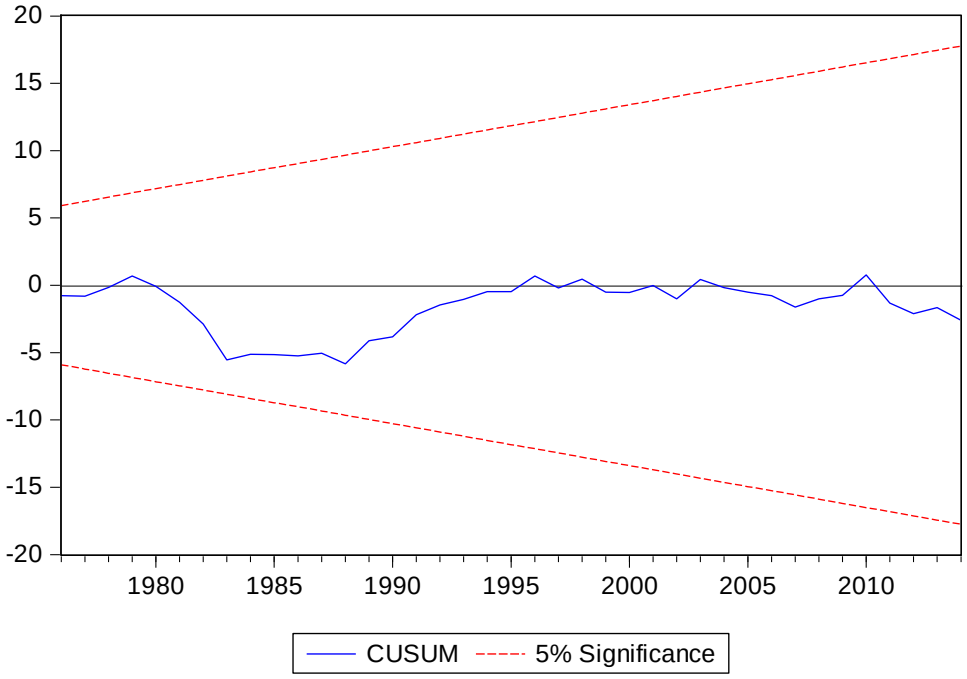

Figure 35: CSSM Test Results for NARDL Model of Belgium

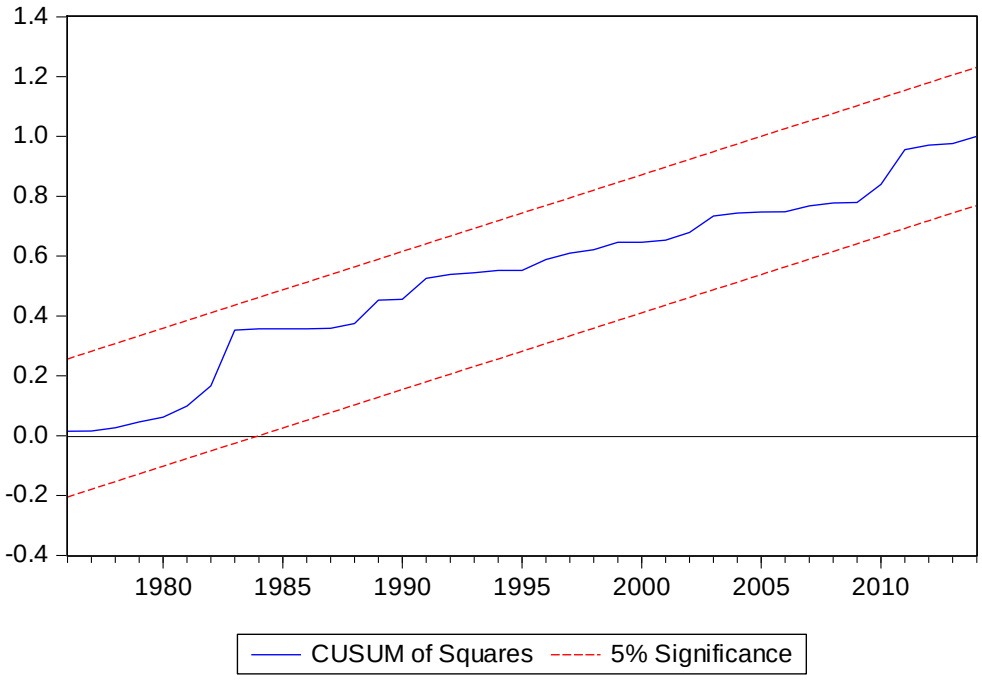

Figure 36: CSQM Test Results for NARDL Model of Belgium

4.2.3 Bootstrap ARDL Model for Belgium

Bootstrap ARDL bounds test is applied to analyze the cointegration between CO2, GDP and SQ. F-statistics value of bounds cointegration test is 2,410 which is less than 4,398 which is the critical value of 10% (see Table 45). No cointegration is found between the variables.

EKC relationship for Belgium is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1960 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,410	6,367	5,059	4,398
Bootstrap P-Value	0,530		
% of Failed Iterations	0,30		

Table 45: PSS Bootstrap F-Test Based on ARDL Model for Belgium

4.3 Sweden

4.3.1 ARDL Model for Sweden

CO2, GDP and SQ at I(1) level according to unit root test results (see Table 46). ENC is at I(0) level according to unit root test results (see Table 46). Lag length is determined according to results in VAR model (see Table 47). F-statistics value of bounds cointegration test is 2.204793 which is less than 3.17 which is I0 bound value of 10%. No cointegration is found between the variables. The model is stable according to the stability test results (see Table 48, Figure 37 and Figure 38).

	Level	First Difference
CO2	-0.225651	-7.274891 (1%)
GDP	-2.615928	-5.158945 (1%)
SQ	-2.335217	-5.242850 (1%)
ENC	-3.727088 (1%)	-

Table 46: UR Results for Sweden

Lag	LogL	LR	FPE	AIC	SC	HQ
0	195.1118	NA	6.54e-09	-7.494581	-7.343066	-7.436683
1	488.6087	529.4454	1.23e-13*	-18.37681*	-17.61923*	-18.08732*
2	495.5768	11.47685	1.78e-13	-18.02262	-16.65898	-17.50153
3	513.2730	26.37076*	1.71e-13	-18.08914	-16.11943	-17.33645
4	525.0277	15.67298	2.15e-13	-17.92266	-15.34689	-16.93838

Table 47: Lag Length Results for Sweden

	F-statistic	Jarque-Bera
RE Test	3.266973 (0.0770)	-
HE Test	0.354577 (0.8396)	-
CO Test	0.041909 (0.8387)	-
NO Test	-	2.646303 (0.266295)

Table 48: Stability Test Results for ARDL Model of Sweden

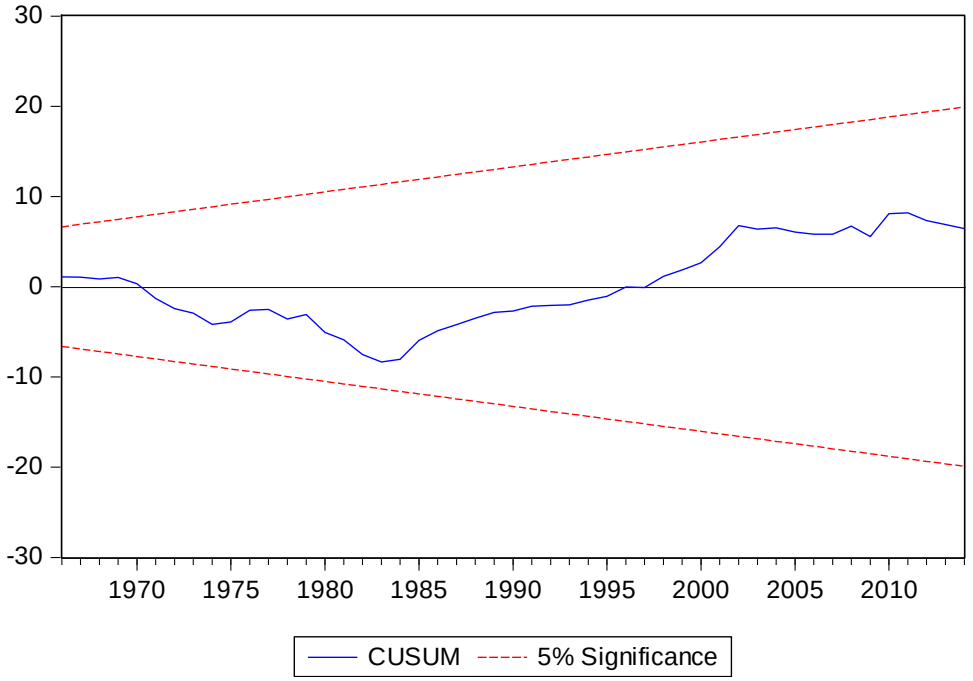

Figure 37: CSSM Test Results for ARDL Model of Sweden

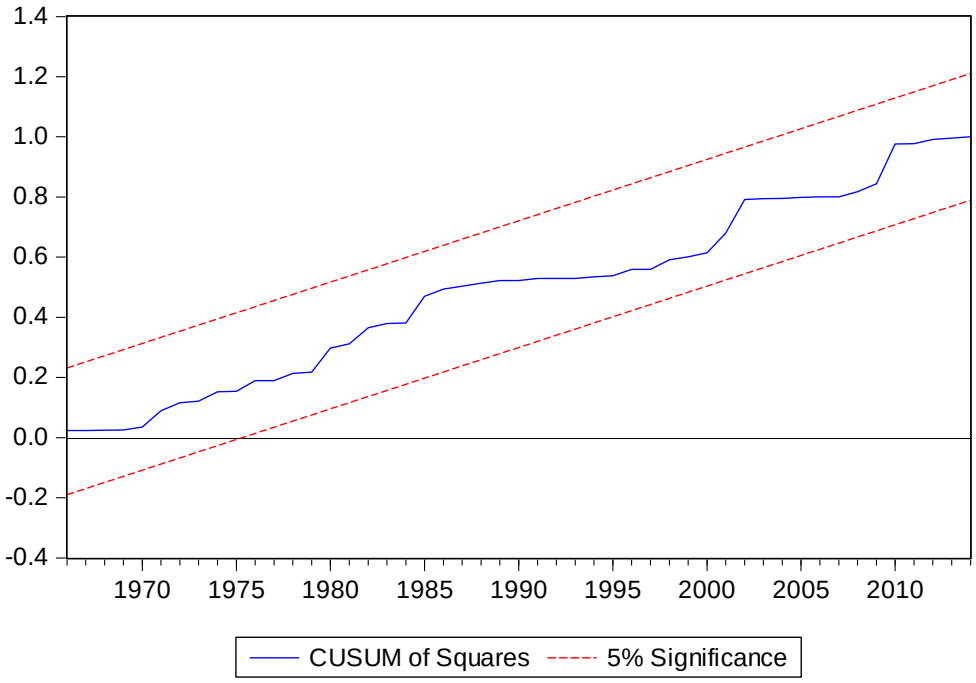

Figure 38: CSQM Test Results for ARDL Model of Sweden

4.3.2 NARDL Model for Sweden

F-statistics value of bounds cointegration test is 2.443363 which is less than 2.72 which is I0 bound value of 10%. No cointegration is found between CO2, GDP, SQ and ENC. NARDL model is stable according to the stability test results (see Table 49, Figure 39 and Figure 40).

	F-statistic	Jarque-Bera
RE Test	3.899716 (0.0542)	-
HE Test	0.336214 (0.8885)	-
CO Test	0.077697 (0.7817)	-
NO Test	-	2.523376 (0.283176)

Table 49: Stability Test Results for NARDL Model of Sweden

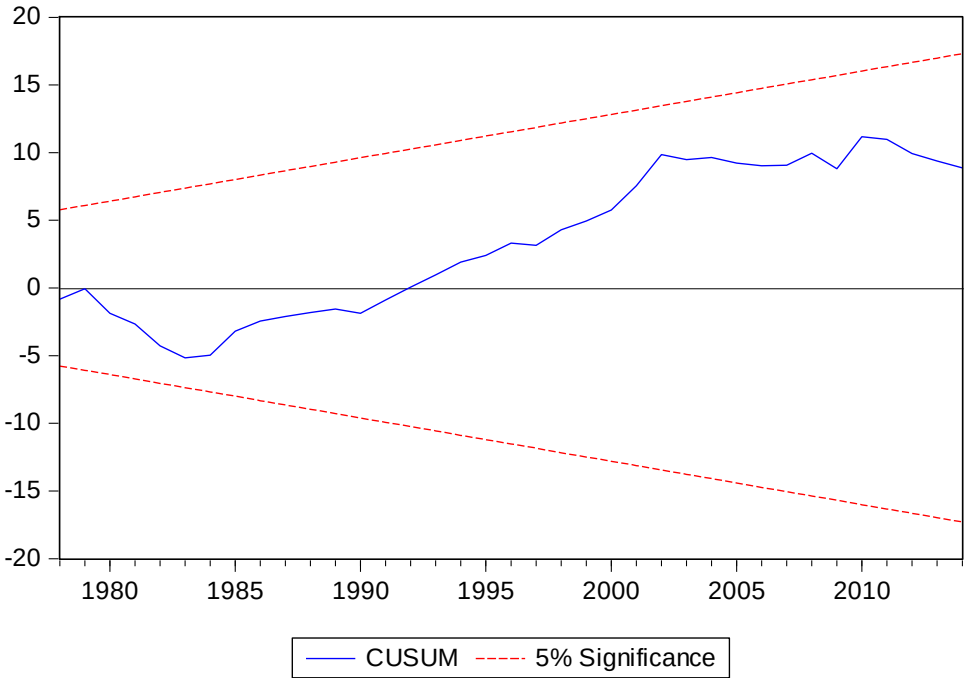

Figure 39: CSSM Test Results for NARDL Model of Sweden

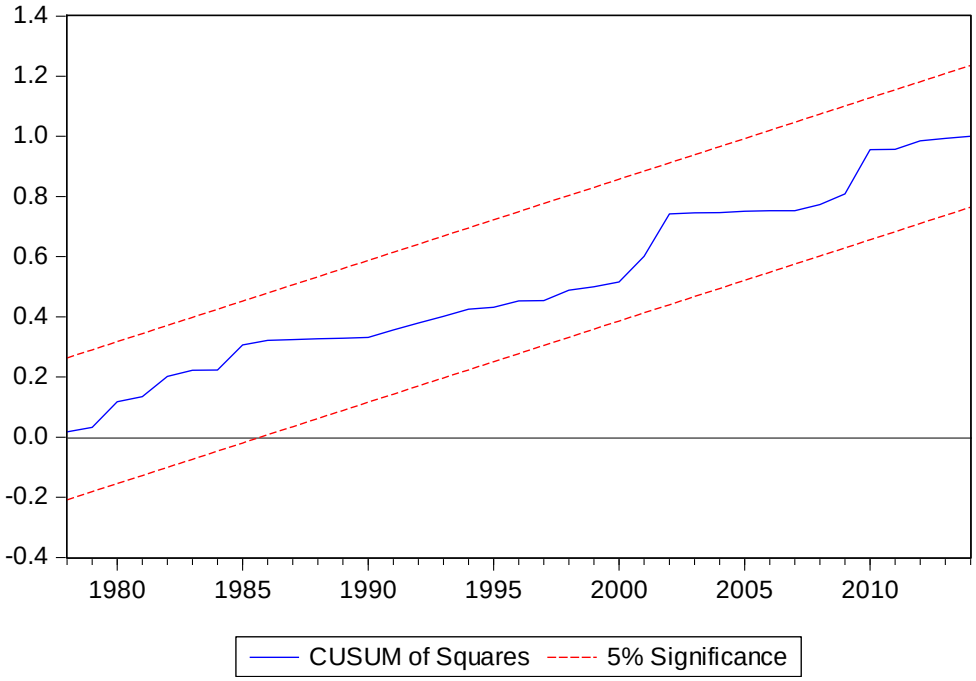

Figure 40: CSQM Test Results for NARDL Model of Sweden

4.3.3 Bootstrap ARDL Model for Sweden

Bootstrap ARDL bounds test is applied to analyze the cointegration between CO2, GDP, SQ and ENC. F-statistics value of bounds cointegration test is 2,894 which is less than 3,393 which is the critical value of 10% (see Table 50). No cointegration is found between the variables.

EKC relationship for Sweden is rejected by ARDL, NARDL and Bootstrap ARDL Models for the period between 1960 and 2014.

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,894	5,428	3,876	3,393
Bootstrap P-Value	0,179		
% of Failed Iterations	0,70		

Table 50: PSS Bootstrap F-Test Based on ARDL Model for Sweden

4.4 Finland

4.4.1 Bootstrap ARDL Model for Finland

GDP and SQ at I(1) level according to unit root test results (see Table 51). CO2 and ENC is at I(0) level according to unit root test results (see Table 51). F-statistics value of bounds cointegration test is 3,079 which is less than 3,907 which is I0 bound value of 10%. No cointegration is found between the variables.

The EKC relationship for Finland is rejected by Bootstrap ARDL Model for the period between 1960 and 2014.

	Level	First Difference
CO2	-3.660118 (1%)	-
GDP	-1.906532	-4.664511 (1%)
SQ	-1.503688	-4.866067 (1%)
ENC	-3.611055 (1%)	-

Table 51: UR Results for Finland

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
3,079	6,629	4,644	3,907
Bootstrap P-Value	0,214		
% of Failed Iterations	1,60		

Table 52: PSS Bootstrap F-Test Based on ARDL Model for Finland

CHAPTER 5
EKC: CASE OF DENMARK, SPAIN AND UK

CO2-GDP-ENC nexus and CO2-GDP-SQ-ENC nexus are tested for Denmark, Spain and UK.

5.1 Denmark

5.1.1 CO2, GDP and ENC Nexus

CO2 is at I(1) level according to unit root test results. GDP, SQ and ENC are at I(0) level according to unit root test results (see Table 53). According to ARDL bounds test results, F-statistics value is 1.304455 which is less than 3.17 which is I0 bound value of 10%. Also, according to Bootstrap ARDL bounds test results, F-statistics value is 2,139 which is less than 4,016 which is the critical value of 10%. According to ARDL bounds test and Bootstrap ARDL bounds test results, there is no cointegration between CO2, GDP and ENC (see Table 57). ARDL model is stable according to the stability test results (see Table 54). The Toda and Yamamoto Granger non-causality test is applied to analyze the causal relationships between the variables. VAR model is stable according to the stability tests (see Figure 41 and Table 55). According to granger causality test results, there is unidirectional causality from energy consumption to CO2. No other causal relationships are found between the variables (see Table 56).

	Level	First Difference
CO2	-1.528636	-7.955326 (1%)
GDP	-3.623015 (1%)	-
SQ	-3.391508 (1%)	-
ENC	-4.039929 (1%)	-

Table 53: UR Results for Denmark

	F-statistic	Jarque-Bera
HE Test	2.194069 (0.0703)	-
CO Test	0.769838 (0.3847)	-
NO Test	-	0.078324 (0.961595)

Table 54: Stability Test Results for CO2-GDP-ENC Nexus for Denmark

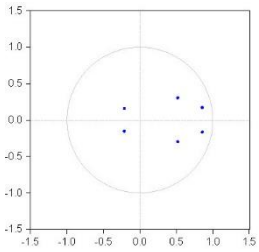

Figure 41: VMSR of CO2-GDP-ENC Nexus for Denmark

Lags	LM-Stat	Prob
1	11.89	0.21
2	12.74	0.17
3	4.39	0.88
4	8.63	0.47
5	21.30	0.01
6	2.61	0.97
7	8.85	0.45
8	2.90	0.96
9	11.24	0.25
10	8.77	0.45

Table 55: VRSC LM Test Results of CO2-GDP-ENC Nexus for Denmark

D. V.: DLNCO_2			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNEN	7.27	2	0.0263
LNGDP	1.31	2	0.5185
All	7.81	4	0.0985
D. V.: DLNEN			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNCO_2	5.04	2	0.0804
LNGDP	0.33	2	0.8457
All	5.77	4	0.2170
D. V.: DLNGDP			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNCO_2	0.39	2	0.8227
LNEN	0.74	2	0.6882
All	1.59	4	0.8092

Table 56: VGC Tests Results of CO2-GDP-ENC Nexus for Denmark

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,139	6,177	4,552	4,016
Bootstrap P-Value	0,536		
% of Failed Iterations	0,40		

Table 57: PSS Bootstrap F-Test Based on ARDL Model for CO2-GDP-ENC Nexus for Denmark

5.1.2 CO2, GDP, SQ and ENC Nexus

According to ARDL bounds test results, F-statistics value is 1.668074 which is less than 2.72 which is I0 bound value of 10%. Also, according to Bootstrap ARDL bounds test results, F-statistics value is 1,961 which is less than 3,734 which is the critical value of 10%. According to ARDL bounds test and Bootstrap ARDL bounds test results, there is no cointegration between CO2, GDP, SQ and ENC (see Table 59). ARDL model is stable according to the stability test results (see Table 58).

	F-statistic	Jarque-Bera
HE Test	1.541021 (0.1775)	-
CO Test	3.249617 (0.0781)	-
NO Test	-	0.060910 (0.970004)

Table 58: Stability Test Results for CO2-GDP-SQ-ENC Nexus for Denmark

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
1,961	5,503	4,422	3,734
Bootstrap P-Value	0,600		
% of Failed Iterations	0,60		

Table 59: PSS Bootstrap F-Test Based on ARDL Model for CO2-GDP-SQ-ENC Nexus for Denmark

5.2 Spain

5.2.1 CO2, GDP and ENC Nexus

CO2 and ENC are at I(0) level according to unit root test results. GDP and SQ are at I(1) level according to unit root test results (see Table 60). According to ARDL bounds test results, F-statistics value is 0.485180 which is less than 3.17 which is I0 bound value of 10%. Also, according to Bootstrap ARDL bounds test results, F-statistics value is 4,338 which is less than 4,431 which is the critical value of 10%.

According to ARDL bounds test and Bootstrap ARDL bounds test results, there is no cointegration between CO2, GDP and ENC (see Table 64). ARDL model is stable according to the stability test results (see Table 61). The Toda and Yamamoto Granger non-causality test is applied to analyze the causal relationships between the variables. VAR model is stable according to the stability tests (see Figure 42 and Table 62). No causal relationships are found between the variables (see Table 63).

	Level	First Difference
CO2	-3.228253 (5%)	-
GDP	-2.245149	-3.518072 (5%)
SQ	-2.138252	-3.462570 (5%)
ENC	-5.484892 (1%)	-

Table 60: UR Results for Spain

	F-statistic	Jarque-Bera
HE Test	1.671547 (0.1326)	-
CO Test	1.911894 (0.1604)	-
NO Test	-	0.365967 (0.832782)

Table 61: Stability Test Results for CO2-GDP-ENC Nexus for Spain

Lags	LM-Stat	Prob
1	9.86	0.3616
2	7.68	0.5664
3	4.39	0.8839
4	15.14	0.0870
5	10.26	0.3298
6	5.63	0.7762

Table 62: VRSC LM Test Results of CO2-GDO-ENC Nexus for Spain

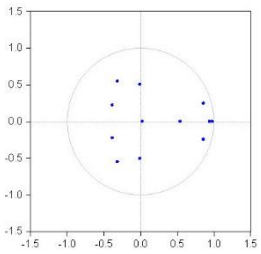

Figure 42: VMSR of CO2-GDP-ENC Nexus for Spain

D. V.: DLNCO2			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNEN	5.32	4	0.2556
LNGDP	3.09	4	0.5426
All	9.26	8	0.3208
D. V.: DLNEN			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNCO2	3.20	4	0.5245
LNGDP	6.30	4	0.1776
All	9.47	8	0.3036
D. V.: DLNGDP			
Excl.	**Chi-sq**	**Df**	**Pb.**
LNCO2	2.08	4	0.7198
LNEN	0.39	4	0.9826
All	2.94	8	0.9379

Table 63: VGC of CO2-GDP-ENC Nexus for Spain

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
4,338	6,868	5,251	4,431
Bootstrap P-Value	0,108		
% of Failed Iterations	0,80		

Table 64: PSS Bootstrap F-Test Based on ARDL Model for CO2-GDP-ENC Nexus for Spain

5.2.2 CO2, GDP, SQ and ENC Nexus

According to ARDL bounds test results, F-statistics value is 1.332407 which is less than 2.72 which is I0 bound value of 10%. According to Bootstrap ARDL bounds test results, F-statistics value is 2,105 which is less than 4,111 which is the critical value of 10%. According to ARDL bounds test and Bootstrap ARDL bounds test results, there is no cointegration between CO2, GDP, SQ and ENC (see Table 66). ARDL model is stable according to the stability test results (see Table 65).

	F-statistic	Jarque-Bera
HE Test	1.547478 (0.1519)	-
CO Test	2.312284 (0.1125)	-
NO Test	-	2.791425 (0.247657)

Table 65: Stability Test Results for CO2-GDP-SQ-ENC Nexus for Spain

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
2,105	6,238	4,575	4,111
Bootstrap P-Value	0,594		
% of Failed Iterations	0,40		

Table 66: PSS Bootstrap F-Test Based on ARDL Model for CO2-GDP-SQ-ENC Nexus for Spain

5.3 UK

5.3.1 CO2, GDP and ENC Nexus

CO2, GDP, SQ and ENC are at I(1) level according to unit root test results (see Table 67). Johansen cointegration test is applied to examine the long run relationship between the variables. According to cointegration test results, there is no cointegration between the variables (see Table 68). Granger causality is examined between the variables (see Table 71). Unidirectional causality from CO2 to EN is found for UK. No other causal relationship is found between the variables. VAR model is stable according to the stability test results (see Table 69, Table 70 and Figure 43).

	Level	First Difference
CO2	1.783106	-8.822031 (1%)
GDP	-1.438637	-4.901942 (1%)
SQ	-1.299673	-4.886959 (1%)
ENC	-0.581018	-6.910146 (1%)

Table 67: UR Results for UK

UCRT (Tr.)				
Hypothesized No. of CE(s)	**Ei.**	**Tr. Stat.**	**0.05 C.V.**	**Prob.**
None	0.24	24.61	29.79	0.1758
At most 1	0.17	10.18	15.49	0.2668
At most 2	0.001	0.07	3.84	0.7779
UCRT (Max. Ei.)				
Hypothesized No. of CE(s)	**Ei.**	**Tr. Stat.**	**0.05 C. V.**	**Prob.**
None	0.24	14.4	21.13	0.3311
At most 1	0.17	10.1	14.26	0.2051
At most 2	0.001	0.079	3.84	0.7779

Table 68: Results for JCT of CO2-GDP-ENC Nexus for UK

Lags	LM-Stat	Prob
1	8.19	0.5146
2	7.83	0.5509

Table 69: VRSC LM Test Results of CO2-GDP-ENC Nexus for UK

Joint test		
Chi-sq	**Df**	**Prob.**
83.06	72	0.1752

Table 70: VRHT of CO2-GDP-EN Nexus for UK

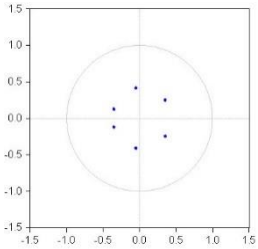

Figure 43: VMSR of CO2-GDP-ENC Nexus for UK

D. V.: DLNCO2			
Excl.	**Chi-sq**	**df**	**Pb.**
LNEN	3.61	2	0.1643
LNGDP	3.54	2	0.1700
All	8.33	4	0.0800
D. V.: DLNEN			
Excl.	**Chi-sq**	**df**	**Pb.**
LNCO2	7.27	2	0.0263
LNGDP	2.83	2	0.2418
All	8.54	4	0.0734
D. V.: DLNGDP			
Excl.	**Chi-sq**	**df**	**Pb.**
LNCO2	1.02	2	0.5976
LNEN	2.96	2	0.2274
All	5.59	4	0.2319

Table 71: VGC/BEW Tests Results of CO2-GDP-ENC Nexus for UK

Variance decomposition analysis and impulse response analysis are carried out to analyze the impact and influence of variables to each other. According

to variance decomposition analysis, CO2 can cause significant fluctuation in ENC and GDP in the short run and in the long run. According to impulse response analysis, CO2 and ENC have no impact on GDP in the long run.

Per.	S.E.	DLNCO2	DLNEN	DLNGDP
1	0.03	100.00	0.00	0.00
2	0.03	89.44	5.00	5.55
3	0.04	89.30	5.45	5.24
4	0.04	88.62	5.79	5.58
5	0.04	88.49	5.89	5.60
6	0.04	88.49	5.89	5.60
7	0.04	88.49	5.89	5.60
8	0.04	88.49	5.89	5.60
9	0.04	88.49	5.89	5.60
10	0.04	88.49	5.89	5.60

Per.	S.E.	DLNCO2	DLNEN	DLNGDP
1	0.03	76.83	23.16	0.00
2	0.03	69.54	25.46	4.99
3	0.03	68.61	26.40	4.97
4	0.03	67.98	26.52	5.49
5	0.03	67.94	26.54	5.51
6	0.03	67.93	26.54	5.51
7	0.03	67.93	26.54	5.51
8	0.03	67.93	26.54	5.51
9	0.03	67.93	26.54	5.51
10	0.03	67.93	26.54	5.51

Per.	S.E.	DLNCO2	DLNEN	DLNGDP
1	0.01	34.55	0.26	65.18
2	0.02	34.77	4.20	61.01
3	0.02	34.56	7.83	57.60
4	0.02	34.38	8.92	56.69
5	0.02	34.42	8.98	56.59
6	0.02	34.42	8.98	56.58
7	0.02	34.42	8.98	56.58
8	0.02	34.42	8.98	56.58
9	0.02	34.42	8.98	56.58
10	0.02	34.42	8.98	56.58

Table 72: VDDA of CO2, ENC and GDP of CO2-GDP-ENC Nexus for UK

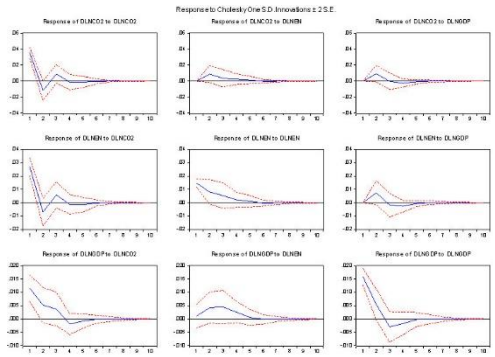

Figure 44: IRRA of CO2-GDP-ENC Nexus for UK

5.3.2 CO2, GDP, SQ and ENC Nexus

Johansen cointegration test is applied to examine the long run relationship between CO2, GDP, SQ and ENC. According to Johansen cointegration test results, no cointegration is found between the variables (see Table 73).

UCRT (Tr.)				
Hypothesized No. of CE(s)	**Ei.**	**Tr. Stat.**	**0.05 C.V.**	**Prob.**
None	0.31	38.41	47.85	0.2842
At most 1	0.25	18.28	29.79	0.5450
At most 2	0.04	2.81	15.49	0.9747
At most 3	0.006	0.33	3.84	0.5602
UCRT (Max. Ei.)				
Hypothesized No. of CE(s)	**Ei.**	**Tr. Stat.**	**0.05 C.V.**	**Prob.**
None	0.31	20.13	27.58	0.3322
At most 1	0.25	15.47	21.13	0.2572
At most 2	0.04	2.47	14.26	0.9754
At most 3	0.006	0.33	3.84	0.5602

Table 73: Results for JCT of CO2-GDP-SQ-ENC Nexus of GDP for UK

CHAPTER 6
COAL CONSUMPTION ENVIRONMENTAL KUZNETS CURVE: CASE OF NEW ZEALAND AND FINLAND

Coal consumption-GDP-SQ nexus is examined for New Zealand for the period between 1980 and 2015. Coal consumption-GDP-SQ nexus is also examined for Finland for the period between 1980 and 2013. ARDL, Bootstrap ARDL and ARDL Dynamic Multiplier models are used in this chapter.

6.1 New Zealand

6.1.1 ARDL Model

CS, GDP and SQ are at I(1) level according to unit root test results (see Table 74). Lag length is determined according to results in VAR model (see Table 75). According to ARDL bounds test results, F-statistics value is 7.541927 which is more than 6.36 which is I1 bound value of 1%. ARDL model is stable according to the stability test results (see Table 76, Figure 45 and Figure 46). ARDL-ECM (ARDL Error Correction Model) is run and according to the results, coal consumption environmental Kuznets curve is confirmed for New Zealand. The long run coefficient of GDP is positive and significant at 5%, and the long run coefficient of SQ is negative and significant at 5%.

	Level	First Difference
CS	-1.169973	-6.304463 (1%)
GDP	-0.662049	-3.789428 (1%)
SQ	-0.577469	-3.828574 (1%)

Table 74: UR Results for New Zealand

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-18.06897	NA	0.000749	1.316810	1.454223	1.362359
1	73.21686	159.7502	4.39e-06	-3.826053	-3.276402	-3.643860
2	89.18937	24.95706*	2.89e-06	-4.261836	-3.299947*	-3.942997*
3	98.79603	13.20915	2.91e-06	-4.299752	-2.925624	-3.844267
4	109.3961	12.58764	2.86e-06*	-4.399759*	-2.613393	-3.807629

Table 75: Lag Length Results for New Zealand

	F-statistic	Jarque-Bera
RE Test	1.476031 (0.2373)	-
HE Test	1.047418 (0.4348)	-
CO Test	0.758028 (0.5653)	-
NO Test	-	2.041149 (0.360388)

Table 76: Stability Test Results for ARDL Model of New Zealand

	Variable	Coef.	Standard Error	t-Stat.	Probability
Short-run Coefficients	D(CS(-1))	0.102793	0.157636	0.652091	0.5208
	D(CS(-2))	0.271383	0.144308	1.880587	0.0728
	D(GDP)	4.770916	3.168924	1.505532	0.1458
	D(GDP(-1))	-14.263593	3.857773	-3.697365	0.0012
	D(SQ)	-0.231627	0.161423	-1.434910	0.1648
	D(SQ(-1))	0.742427	0.197288	3.763160	0.0010
	CointEq(-1)	-0.442717	0.114486	-3.866995	0.0008
Long-run Coefficients	GDP	12.129168	3.458242	3.507322	0.0019
	SQ	-0.599427	0.177671	-3.373797	0.0026
	C	-60.796118	16.791139	-3.620726	0.0014

Table 77: ARDL-ECM Test Results for New Zealand

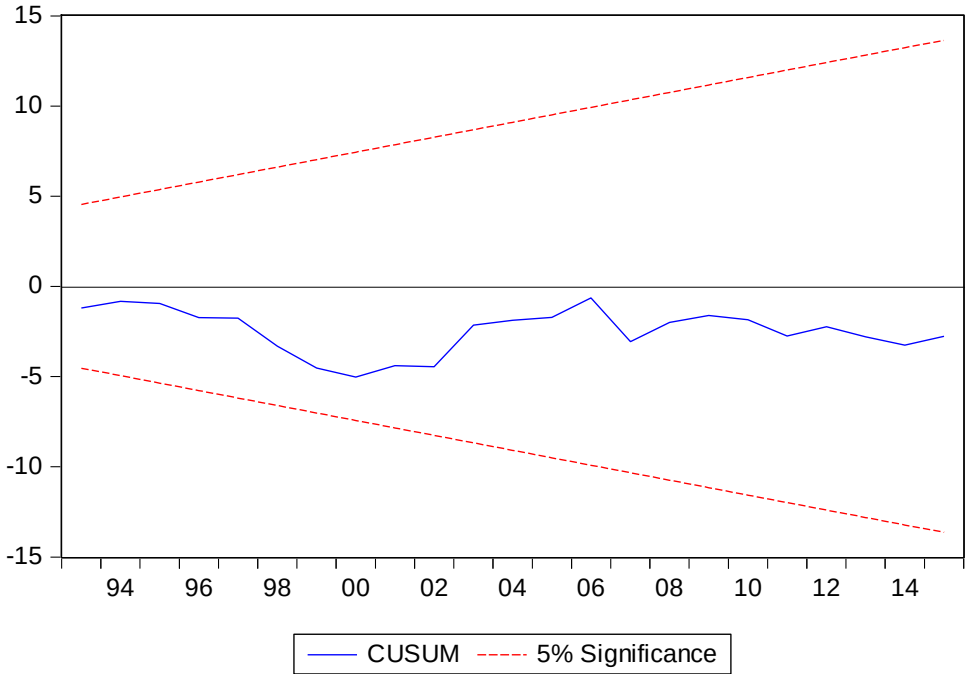

Figure 45: CSSM Test Results for ARDL Model of New Zealand

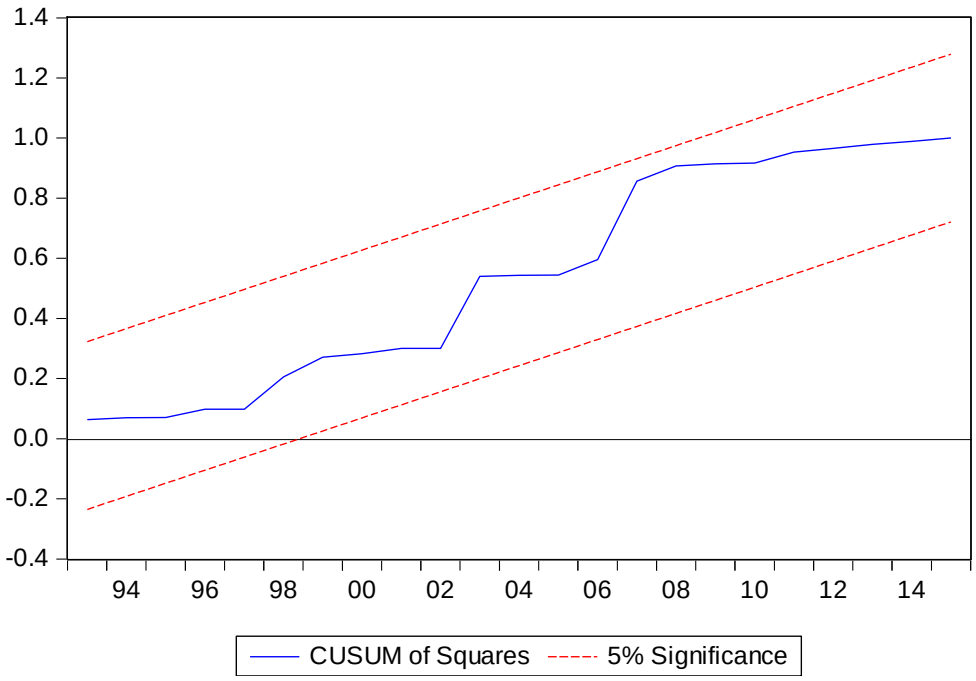

Figure 46: CSQM Test Results for ARDL Model of New Zealand

6.1.2 Bootstrap ARDL Model

According to Bootstrap ARDL Bounds Tests, there is long run relationship between CS, GDP and SQ (see Table 78, Table 79 and Table 80). ARDL Dynamic Multiplier Error Correction Model is run and coal consumption environmental Kuznets curve is confirmed according to the results (see Table 81, Figure 47 and Figure 48).

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
5,702	6,308	4,550	3,919
Bootstrap P-Value	0,032		
% of Failed Iterations	0,90		

Table 78: PSS Bootstrap F-Test Based on ARDL Model for New Zealand

BDM BS T Test	Critical Values		
Initial Test Statistics	1%	5%	10%
8,390	11,258	7,405	6,122
Bootstrap P-Value	0,033		
% of Failed Iterations	2,90		

Table 79: BDM Bootstrap T-Test Based on ARDL Model for New Zealand

Lags	AIC	BIC	HQ
1	-1,2399	-0,9705	-1,1480
2	-1,4991*	-1,0951	-1,3613

Table 80: Lag Selection Results for New Zealand

Error Correction Rho (Bootstrap Values)			
	Mean	**Median**	**S.D.**
Rho	-0,4839	-0,4679	0,1321
Long-Run Multipliers (Bootstrap Values)			
	Mean	**Median**	**S.D.**
CS	1,2333	1,1374	0,6671
GDP	13,0108	12,7031	3,3887
SQ	-0,6464	-0,6305	0,1747
Bewley's long-run multipliers (2SLS point estimates)			
	Coefficient	**S.D.**	
GDP	13,5888	3,3484	
SQ	-0,6772	0,1715	

Table 81: ARDL Dynamic Multiplier Model Error Correction Bootstrap Coefficient Estimates

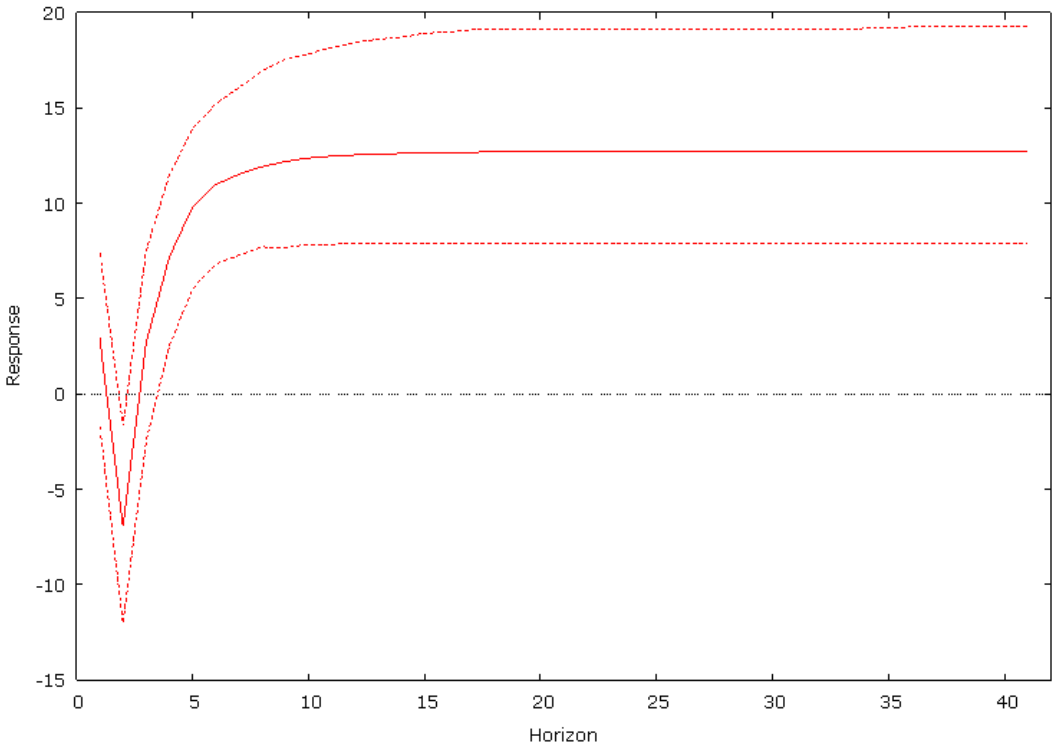

Figure 47: Shock of GDP on CS for New Zealand

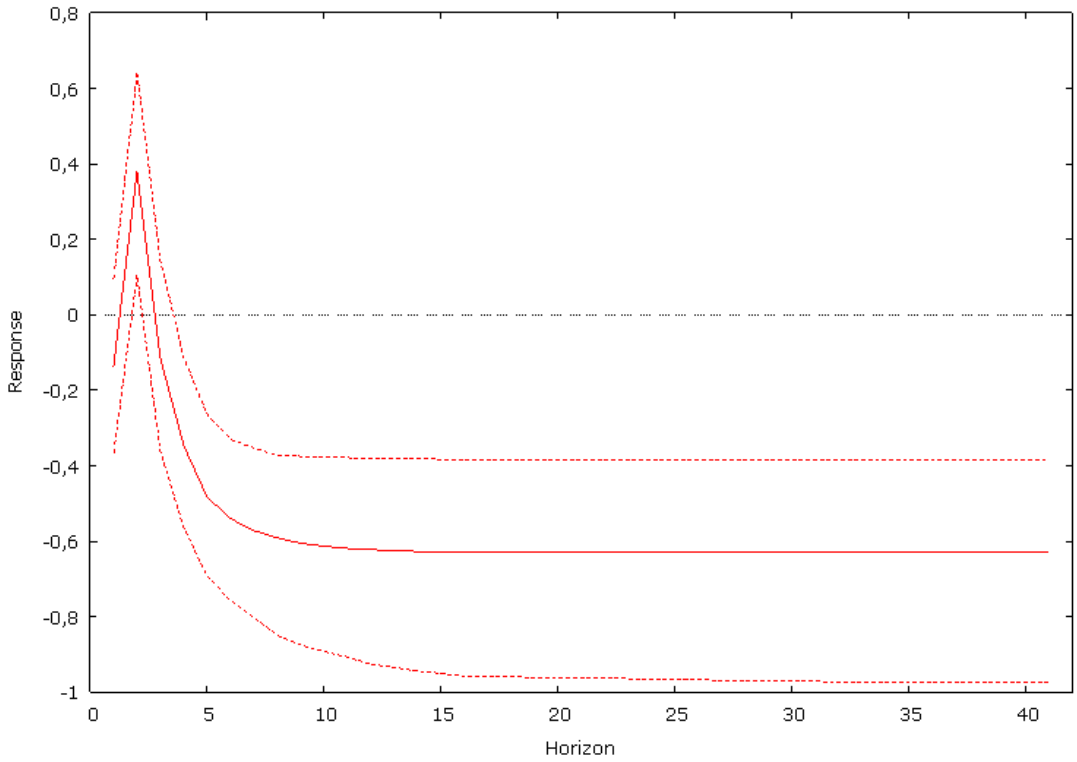

Figure 48: Shock of SQ on CS for New Zealand

6.2 Finland

6.2.1 ARDL Model

CS, GDP and SQ are at I(1) level according to unit root test results (see Table 82). ENC is at I(0) level according to unit root test results (see Table 82).Lag length is determined according to results in VAR model (see Table 83). According to ARDL bounds test results, F-statistics value is 6.625140 which is more than 5.61 which is I1 bound value of 1%. ARDL model is stable according to the stability test results (see Table 84, Figure 49 and Figure 50). ARDL-ECM (ARDL Error Correction Model) is run and according to the results, coal consumption environmental Kuznets curve is confirmed for Finland. The long run coefficient of GDP is positive and significant at 5%, and the long run coefficient of SQ is negative and significant at 5%.

	Level	First Difference
CS	-3.313695 (5%)	-
GDP	-0.935354	-4.091487 (1%)
SQ	-0.866728	-4.155341 (1%)
ENC	-1.568279	-6.613416 (1%)

Table 82: UR Results for Finland

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-8.459043	NA	2.70e-05	0.830603	1.017429	0.890370
1	97.11426	175.9555	6.96e-08	-5.140950	-4.206819*	-4.842114
2	122.2977	35.25677*	4.02e-08*	-5.753178	-4.071741	-5.215272*
3	138.6355	18.51619	4.66e-08	-5.775698	-3.346956	-4.998723
4	156.0706	15.11048	6.08e-08	-5.871376*	-2.695329	-4.855332

Table 83: Lag Length Results for Finland

	F-statistic	Jarque-Bera
RE Test	0.411273 (0.5290)	-
HE Test	0.350381 (0.9613)	-
CO Test	1.247566 (0.3109)	-
NO Test	-	1.445746 (0.485356)

Table 84: Stability Test Results for ARDL Model of Finland

	Variable	Coef.	Standard Error	t-Stat.	Probability
Short-run Coefficients	D(CS(-1))	-0.173342	0.171012	-1.013626	0.3229
	D(GDP)	-15.432370	21.546929	-0.716221	0.4821
	D(GDP(-1))	-29.542696	25.161799	-1.174109	0.2541
	D(SQ)	0.779350	1.059203	0.735789	0.4704
	D(SQ(-1))	1.349766	1.238331	1.089988	0.2887
	D(ENC)	15.904177	2.359748	6.739777	0.0000
	D(ENC(-1))	1.400658	4.252801	0.329349	0.7453
	CointEq(-1)	-0.638493	0.141473	-4.513189	0.0002
Long-run Coefficients	GDP	53.568471	14.608278	3.666994	0.0015
	SQ	-2.598180	0.713300	-3.642481	0.0016
	ENC	22.500556	3.880123	5.798928	0.0000
	C	-442.005056	66.285110	-6.668241	0.0000

Table 85: ARDL-ECM Test Results for Finland

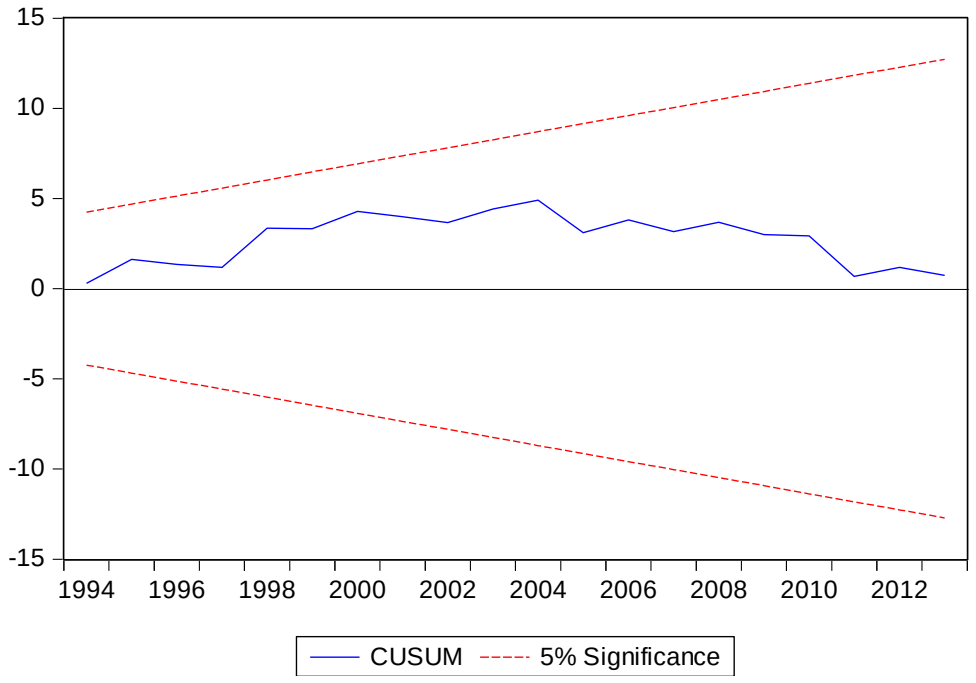

Figure 49: CSSM Test Results for ARDL Model of Finland

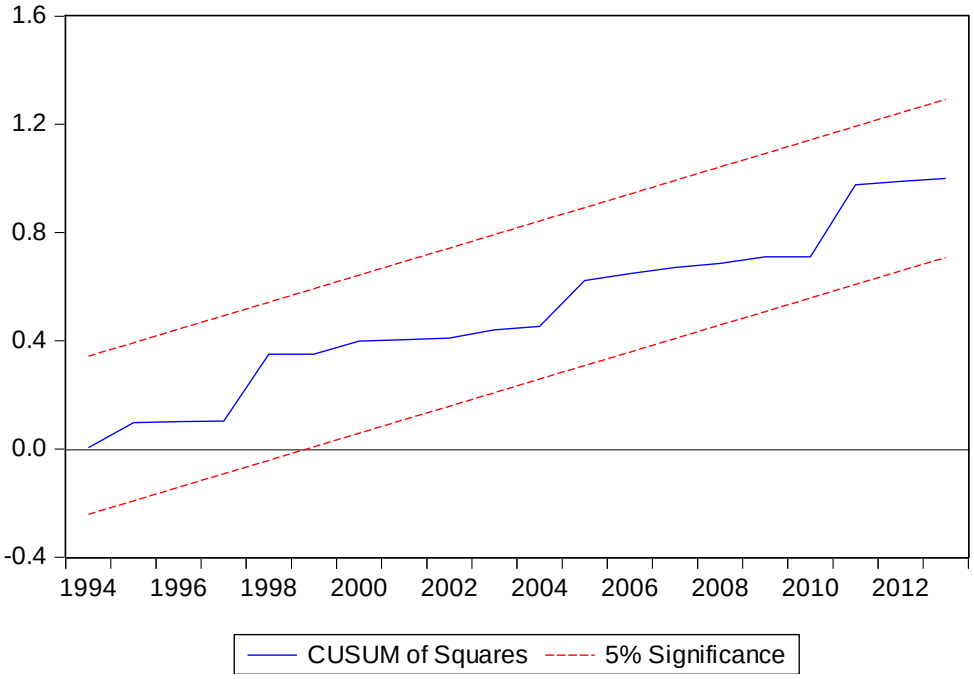

Figure 50: CSQM Test Results for ARDL Model of Finland

6.2.2 Bootstrap ARDL Model

According to Bootstrap ARDL Bounds Tests, there is long run relationship between CS, GDP and SQ (see Table 86, Table 87 and Table 88). ARDL Dynamic Multiplier Error Correction Model is run and coal consumption environmental Kuznets curve is confirmed according to the results (see Table 89, Figure 51, Figure 52 and Figure 53).

PSS BS F Test	Critical Values		
Initial Test Statistics	1%	5%	10%
5,990	6,749	4,701	4,043
Bootstrap P-Value	0,015		
% of Failed Iterations	0,60		

Table 86: PSS Bootstrap F-Test Based on ARDL Model for Finland

BDM BS T Test	Critical Values		
Initial Test Statistics	1%	5%	10%
11,935	9,683	6,307	5,127
Bootstrap P-Value	0,002		
% of Failed Iterations	8,91		

Table 87: BDM Bootstrap T-Test Based on ARDL Model for Finland

Lags	AIC	BIC	HQ
1	1,8348	2,2012	1,9562
2	1,6299*	2,1796	1,8121

Table 88: Lag Selection Results for Finland

Error Correction Rho (Bootstrap Values)			
	Mean	**Median**	**S.D.**
Rho	-0,7133	-0,7036	0,1318
Long-Run Multipliers (Bootstrap Values)			
	Mean	**Median**	**S.D.**
CS	0,4525	0,4213	0,2854
GDP	52,1697	51,7253	12,1087
SQ	-2,5262	-2,4979	0,5904
EN	22,4001	22,4543	3,0780
Bewley's long-run multipliers (2SLS point estimates)			
	Coefficient	**S.D.**	
GDP	53,5685	8,9163	
SQ	-2,5982	0,4386	
EN	22,5006	2,4413	

Table 89: ARDL Dynamic Multiplier Model Error Correction Bootstrap Coefficient Estimates

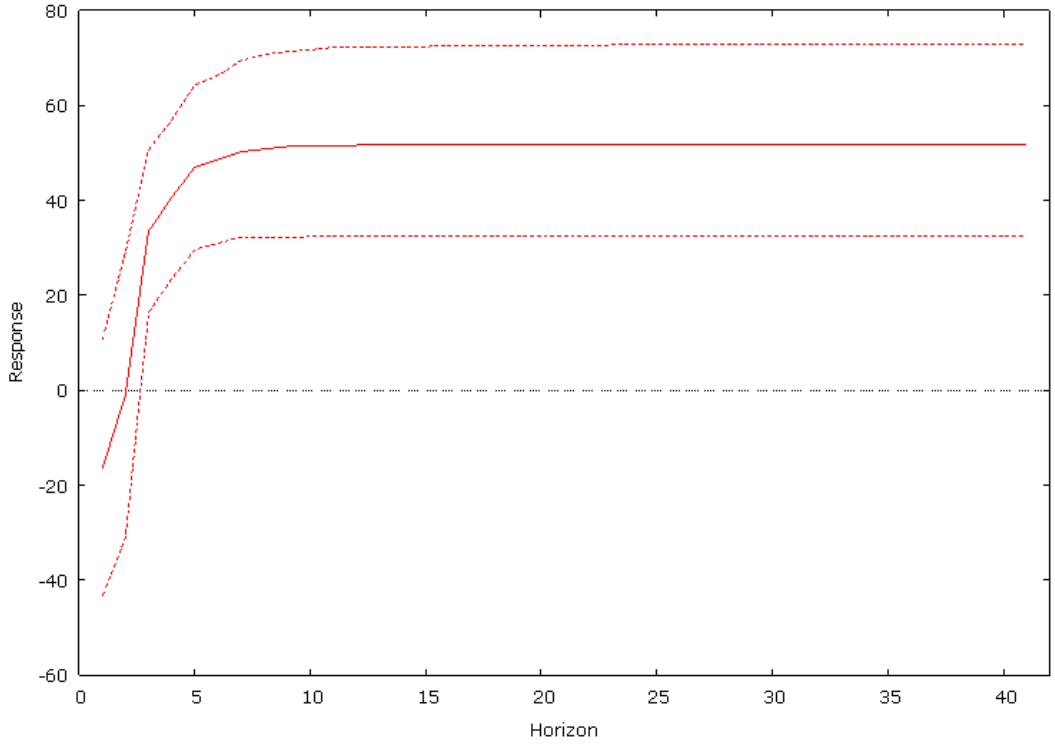

Figure 51: Shock of GDP on CS for Finland

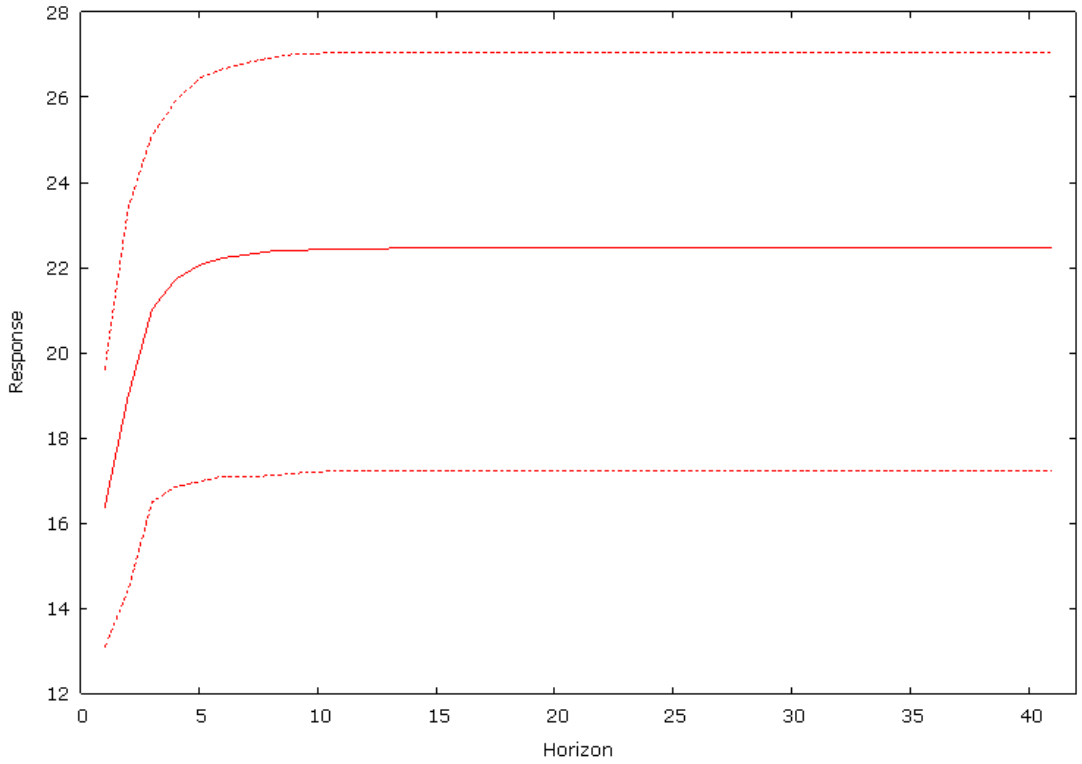

Figure 52: Shock of ENC on CS for Finland

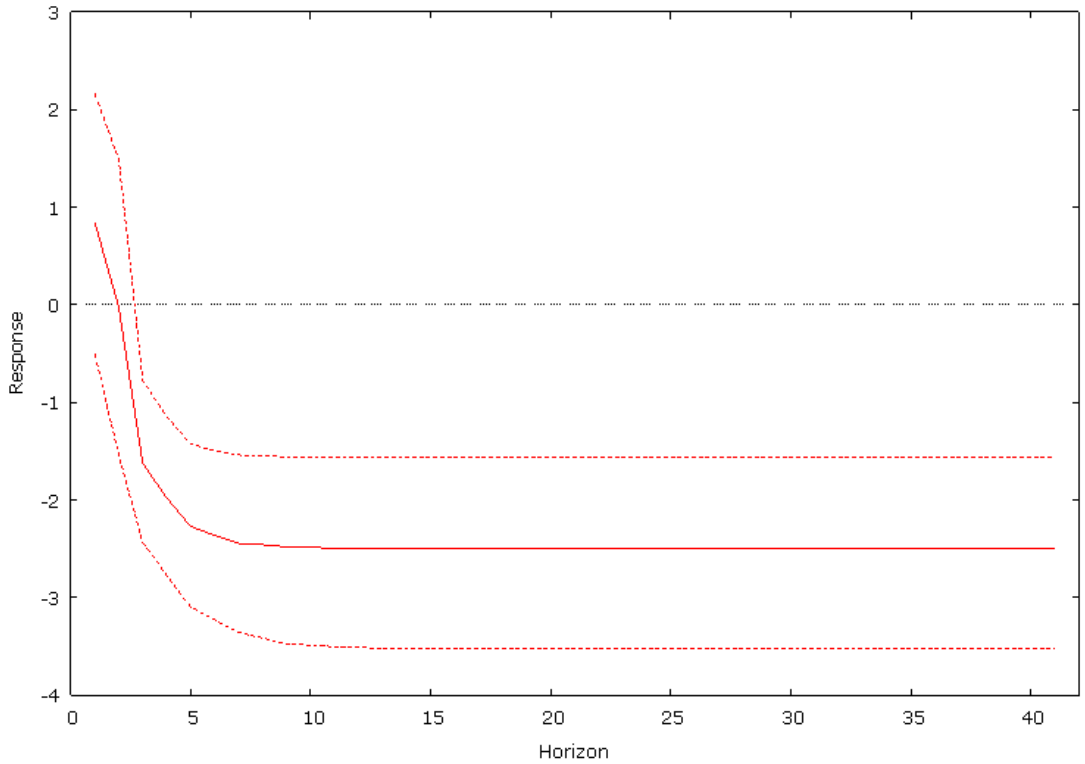

Figure 53: Shock of SQ on CS for Finland

CHAPTER 7
EFFECT OF KYOTO PROTOCOL ON DEVELOPING COUNTRIES

CO2-GDP-SQ-ENC nexus is examined for the developing countries for the period between 1971 and 1997 in part 7.1, and for the period between 1997 and 2014 in part 7.2. Developing countries are Argentina, Egypt, India, Iran, Kenya, Malaysia, Morocco, Nigeria and Turkey. Dynamic common correlated effects estimator pool mean group, cross-sectional augmented distributed lag, and cross-section ARDL models are used in this chapter.

7.1 Developing Countries CO2-GDP-SQ-ENC Nexus Between 1971 and 1997

Cross-sectional dependency tests are applied. According to cross-sectional dependency tests, there is cross-sectional dependency in panel data (see Table 90, Table 91 and Table 92). First generation panel unit root tests are applied. According to results, all variables are at I(1) level (see Table 93 and Table 94). Since cross-sectional dependency exists in panel data, second generation panel unit root test are applied (see Table 95 and Table 96). Westerlund cointegration test is applied to examine the cointegration between the variables. According to Westerlund cointegration test, there is no long-run relationship between the variables (see Table 97). Since cointegration test is optional, further analysis is applied. Hausman test is applied to test between fixed effect and random effect (see Table 98). After random effect is chosen as appropriate model, hausman test is applied again to decide between mean group and pooled mean group (see Table 99). CS-ARDL, CCE-PMG and CS-DL models are applied. According to CS-ARDL model results, although

cointegration exists between the variables, EKC hypothesis is not confirmed for panel countries (see Table 100). According to CCE-PMG model results, no cointegration exists between the variables and EKC hypothesis is not confirmed for panel countries (see Table 101). According to CS-DL model results, EKC hypothesis is not confirmed for panel countries (see Table 102).

Variable	CD-test	p-value	Corr	abs(corr)
CO2	4.54	0.000	0.130	0.491
GDP	2.03	0.042	0.058	0.632
SQ	2.08	0.038	0.060	0.631
ENC	18.96	0.000	0.544	0.633

Table 90: Pesaran (2004) test for cross-sectional dependence for Developing Countries (1971 – 1997)

Variable	CD	P-Value
CO2	-1.854	0.064
GDP	34.833	0.000
SQ	34.761	0.000
ENC	34.838	0.000

Table 91: Pesaran (2015) test for weak cross-sectional dependence for Developing Countries (1971 – 1997)

Variable	CD-Test	P-Value	Average Joint T	Mean P	Mean abs (p)
CO2	4.535	0.000	27.00	0.13	0.49
GDP	2.035	0.042	27.00	0.06	0.63
SQ	2.077	0.038	27.00	0.06	0.63
ENC	18.96	0.000	27.00	0.54	0.63

Table 92: Pesaran (2004) and Pesaran (2015) test for cross-sectional dependence for Developing Countries (1971 – 1997)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	1.9569	0.9748	-8.9322	0.0000
GDP	2.2245	0.9869	-6.5064	0.0000
SQ	2.4575	0.9930	-6.4167	0.0000
ENC	1.1465	0.8742	-7.1331	0.0000

Table 93: Im-Pesaran-Shin UR Results for Developing Countries (1971 – 1997)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	1.2348	0.8915	-7.9976	0.0000
GDP	0.1210	0.5482	-5.2594	0.0000
SQ	0.4546	0.6753	-5.1705	0.0000
ENC	-0.0957	0.4619	-6.8764	0.0000

Table 94: Levin-Lin-Chu UR Results for Developing Countries (1971 – 1997)

	Level	First Difference	Critical Values		
Variable	CIPS	CIPS	10%	5%	1%
CO2	-1.492	-5.246	-2.21	-2.33	-2.57
GDP	-1.261	-4.180	-2.21	-2.33	-2.57
SQ	-1.222	-4.169	-2.21	-2.33	-2.57
ENC	-2.069	-4.564	-2.21	-2.33	-2.57

Table 95: Pesaran (2007) Panel UR for Developing Countries (1971 – 1997)

	Level			First Difference			Critical Values		
Variable	t-bar	Z-t-bar	P-Value	t-bar	Z-t-bar	P-Value	10%	5%	1%
CO2	-1.291	1.529	0.937	-3.919	-7.037	0.000	-2.210	-2.330	-2.570
GDP	-1.118	2.092	0.982	-3.279	-4.593	0.000	-2.210	-2.330	-2.570
SQ	-1.059	2.286	0.989	-3.226	-4.780	0.000	-2.210	-2.330	-2.570
ENC	-2.329	-1.855	0.032	-3.839	-6.778	0.000	-2.210	-2.330	-2.570

Table 96: Pesaran (2003) Panel UR for Developing Countries (1971 – 1997)

CO2-GDP-SQ-ENC Nexus				
Statistic	Value	Z-Value	P-Value	Robust P-Value
Gt	-1.611	0.305	0.620	0.387
Ga	-4.775	1.537	0.938	0.310
Pt	-5.285	-0.855	0.196	0.240
Pa	-2.775	0.748	0.773	0.520
CO2-GDP-SQ Nexus				
Statistic	Value	Z-Value	P-Value	Robust P-Value
Gt	-1.861	-1.448	0.074	0.077
Ga	-5.149	0.390	0.652	0.143
Pt	-6.125	-2.379	0.009	0.063
Pa	.-4.330	-1.181	0.119	0.160

Table 97: Westerlund (2007) Bootstrap Panel Cointegration Test for Developing Countries (1971 – 1997)

CO2-GDP-SQ-ENC Nexus	
Chi2(3)	**Prob**
0.61	0.8932
CO2-GDP-SQ Nexus	
Chi2(2)	**Prob**
2.09	0.3513

Table 98: Hausman Test for Fixed Effect vs. Random Effect for Developing Countries (1971 – 1997)

CO2-GDP-SQ-ENC Nexus	
Chi2(3)	**Prob**
1.57	0.6670
CO2-GDP-SQ Nexus	
Chi2(2)	**Prob**
2.67	0.2631

Table 99: Hausman Test for MG vs. PMG for Developing Countries (1971 – 1997)

CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
SRR Estimates						
MG						
L.CO2	0.1409255	0.1268518	1.11	0.267	-0.1076994	0.3895505
GDP	-17.01414	13.32609	-1.28	0.202	-43.13279	9.104514
SQ	1.323612	0.9848225	1.34	0.179	-0.6066045	3.253829
L.GDP	30.88922	23.01034	1.34	0.179	-14.21022	75.98866
L2.GDP	4.545223	7.737622	0.59	0.557	-10.62024	19.71068
L.SQ	-2.207253	1.701578	-1.30	0.195	-5.542286	1.127779
L2.SQ	-0.3855183	0.5198035	-0.74	0.458	-1.404314	0.6332779
LRR Estimates						
MG						
LR_CO2	-0.8590745	0.1268518	-6.77	0.000	-1.107699	-0.6104495
LR_GDP	38.73629	29.37179	1.32	0.187	-18.83137	96.30394
LR_SQ	-2.642682	2.112223	-1.25	0.211	-6.782563	1.497199
CD Statistic	-1.81	P-Value	0.0701			

Table 100: SRR and LRR Results for CS-ARDL for Developing Countries (1971 – 1997)

D.CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
SRR Estimates						
MG						
D.GDP	-36.9613	23.96122	-1.54	0.123	-83.92442	10.00183
D2.GDP	28.58131	24.15473	1.18	0.237	-18.76109	75.9237
D.SQ	2.718548	1.724587	1.58	0.115	-0.6615807	6.098677
D2.SQ	-2.133922	1.793342	-1.19	0.234	-5.648808	1.380964
LRR Estimates						
Pooled						
L.CO2	-0.7003947	0.538322	-1.30	0.193	-1.755486	0.354697
GDP	1.657057	17.78836	0.09	0.926	-33.20749	36.5216
SQ	-0.0561204	1.266682	-0.04	0.965	-2.538771	2.42653
CD Statistic	-1.59	P-Value	0.1121			

Table 101: SRR and LRR Results for CCE-PMG for Developing Countries (1971 – 1997)

CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
MG						
GDP	-27.99055	20.98552	-1.33	0.182	-69.12141	13.1403
SQ	2.097335	1.566263	1.34	0.181	-0.9724847	5.167154
ENC	0.5094035	0.3937138	1.29	0.196	-0.2622613	1.281068
D.GDP	-0.1424516	0.1638132	-0.87	0.385	-0.4635196	0.1786165
LD.GDP	-0.1944285	0.0991779	-1.96	0.050	-0.3888136	-0.0000435
D.ENC	0.1037665	0.2724869	0.38	0.703	-0.4302981	0.6378311
LD.ENC	1.000028	0.5630336	1.78	0.076	-0.1034971	2.103554
CD Statistic	-1.35	P-Value	0.1784			

Table 102: LRR Results for CS-DL (CCE-MG) for Developing Countries (1971 – 1997)

7.2 Developing Countries CO2-GDP-SQ-ENC Nexus Between 1997 and 2014

Cross-sectional dependency tests are applied. According to cross-sectional dependency tests, there is cross-sectional dependency in panel data (see

Table 103, Table 104 and Table 105). First generation panel unit root tests are applied. According to results, all variables are at I(1) level (see Table 106 and Table 107). Since cross-sectional dependency exists in panel data, second generation panel unit root test are applied (see Table 108 and Table 109). Hausman test is applied to test between fixed effect and random effect (see Table 110). After random effect is chosen as appropriate model, hausman test is applied again to decide between mean group and pooled mean group (see Table 111). CS-ARDL, CCE-PMG and CS-DL models are applied. According to CS-ARDL model results, although cointegration exists between the variables, EKC hypothesis is not confirmed for panel countries (see Table 112). According to CCE-PMG model results, cointegration exists between the variables and EKC hypothesis is not confirmed for panel countries (see Table 113). According to CS-DL model results, EKC hypothesis is not confirmed for panel countries (see Table 114).

Variable	CD-test	p-value	Corr	abs(corr)
CO2	15.24	0.000	0.535	0.576
GDP	25.88	0.000	0.909	0.909
SQ	25.89	0.000	0.910	0.910
ENC	17.02	0.000	0.598	0.759

Table 103: Pesaran (2004) test for cross-sectional dependence for Developing Countries (1997 – 2014)

Variable	CD	P-Value
CO2	2.105	0.035
GDP	28.457	0.000
SQ	28.446	0.000
ENC	28.455	0.000

Table 104: Pesaran (2015) test for weak cross-sectional dependence for Developing Countries (1997 – 2014)

Variable	CD-Test	P-Value	Average Joint T	Mean P	Mean abs (p)
CO2	15.238	0.000	18.00	0.54	0.58
GDP	25.878	0.000	18.00	0.91	0.91
SQ	25.894	0.000	18.00	0.91	0.91
ENC	17.023	0.000	18.00	0.60	0.76

Table 105: Pesaran (2004) and Pesaran (2015) test for cross-sectional dependence for Developing Countries (1997 – 2014)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	1.5368	0.9378	-6.1165	0.0000
GDP	2.3604	0.9909	-4.7417	0.0000
SQ	2.5521	0.9946	-4.6998	0.0000
ENC	1.9941	0.9769	-5.2183	0.0000

Table 106: Im-Pesaran-Shin UR Results for Developing Countries (1997 – 2014)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	-1.0196	0.1540	-10.2064	0.0000
GDP1	0.4504	0.6738	-4.0855	0.0000
GDP2	0.7472	0.7725	-4.0524	0.0000
EC	-0.2552	0.3993	-3.6947	0.0001

Table 107: Levin-Lin-Chu UR Results for Developing Countries (1997 – 2014)

	Level	First Difference	Critical Values		
Variable	CIPS	CIPS	10%	5%	1%
CO2	-2.288	-3.608	-2.21	-2.34	-2.6
GDP	-1.540	-3.911	-2.21	-2.34	-2.6
GDP2	-1.475	-3.850	-2.21	-2.34	-2.6
EN	-1.884	-3.531	-2.21	-2.34	-2.6

Table 108: Pesaran (2007) Panel UR for Developing Countries (1997 – 2014)

	Level			First Difference			Critical Values		
Variable	t-bar	Z-t-bar	P-Value	t-bar	Z-t-bar	P-Value	10%	5%	1%
CO2	-2.288	-1.713	0.043	-3.608	-5.767	0.000	-2.210	-2.340	-2.600
GDP	-1.566	0.503	0.692	-2.397	-2.047	0.020	-2.210	-2.340	-2.600
GDP2	-1.509	0.678	0.751	-2.322	-1.818	0.035	-2.210	-2.340	-2.600
EN	-2.069	-1.042	0.149	-2.802	-3.291	0.000	-2.210	-2.340	-2.600

Table 109: Pesaran (2003) Panel UR for Developing Countries (1997 – 2014)

Chi2(3)	**Prob**
3.42	0.3307

Table 110: Hausman Test for Fixed Effect vs. Random Effect for Developing Countries (1997 – 2014)

Chi2(3)	**Prob**
2.19	0.5338

Table 111: Hausman Test for MG vs. PMG for Developing Countries (1997 – 2014)

CO2	Coef.	Std. Err.	Z	P>Iz I	[95% Conf. Interval]	
SRR Estimates						
MG						
L.CO2	0.0459495	0.1217254	0.38	0.706	-0.1926279	0.2845268
GDP	45.42324	27.79935	1.63	0.102	-9.062484	99.90896
SQ	-3.123152	1.948767	-1.60	0.109	-6.942664	0.6963604
ENC	1.515661	0.3124788	4.85	0.000	0.9032135	2.128108
L.GDP	-17.72587	24.95869	-0.71	0.478	-66.644	31.19226
L.SQ	1.118642	1.642941	0.68	0.496	-2.101462	4.338747
L.ENC	-0.167479	0.294033	-0.57	0.569	-0.7437731	0.408815
LRR Estimates						
Mean Group						
LR_CO2	-0.9540505	0.1217254	-7.84	0.000	-1.192628	-0.7154732
LR_ENC	1.426848	0.5716276	2.50	0.013	0.3064786	2.547218
LR_GDP	26.62014	32.41587	0.82	0.412	-36.91379	90.15408
LR_SQ	-1.901189	2.329932	-0.82	0.415	-6.467771	2.665394
CD Statistic	1.21	P-Value	0.2271			

Table 112: SRR and LRR Results for CS-ARDL for Developing Countries (1997 – 2014)

D.CO2	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
SRR Estimates						
MG						
D.GDP	21.931	10.37159	2.11	0.034	1.603046	42.25895
D.SQ	-1.456899	0.6689874	-2.18	0.029	-2.76809	0.1457078
D.ENC	0.5992738	0.1858947	3.22	0.001	0.2349268	0.9636207
LRR Estimates						
Pooled						
L.CO2	-0.5447766	0.2290375	-2.38	0.017	-0.9936819	-0.0958714
GDP	4.341269	16.90868	0.26	0.797	-28.79913	37.48167
SQ	-0.2528071	1.152087	-0.22	0.826	-2.510856	2.005242
ENC	1.185402	0.4793763	2.47	0.013	0.2458416	2.124962
CD Statistic	-1.13	P-Value	0.2578			

Table 113: SRR and LRR Results for CCE-PMG for Developing Countries (1997 – 2014)

CO2	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
MG						
GDP	30.72245	32.02246	0.96	0.337	-32.04042	93.48531
SQ	-2.199211	2.305576	-0.95	0.340	-6.718056	2.319634
ENC	1.444556	0.5072624	2.85	0.004	0.4503397	2.438772
D.GDP	-0.7209948	0.4066496	-1.77	0.076	1.518013	0.0760238
D.ENC	-0.0455901	0.2903816	-0.16	0.875	-0.6147276	0.5235473
CD Statistic	0.24	P-Value	0.8119			

Table 114: LRR Results for CS-DL (CCE-MG) for Developing Countries (1997 – 2014)

CHAPTER 8
EFFECT OF KYOTO PROTOCOL ON DEVELOPED COUNTRIES

CO2-GDP-SQ-ENC nexus is examined for the developed countries for the period between 1971 and 1997 in part 8.1, and for the period between 1997 and 2014 in part 8.2. Developed countries are Sweden, Denmark, Australia, Portugal, Austria, Canada, Finland, Spain and UK. Dynamic common correlated effects estimator pooled mean group, cross-sectional augmented distributed lag, and cross-section ARDL models are used in this chapter.

8.1 Developed Countries CO2-GDP-SQ-ENC Nexus Between 1971 and 1997

Cross-sectional dependency tests are applied. According to cross-sectional dependency tests, there is cross-sectional dependency in panel data (see Table 115, Table 116 and Table 117). First generation panel unit root tests are applied (see Table 118 and Table 119). Since cross-sectional dependency exists in panel data, second generation panel unit root test are applied (see Table 120 and Table 121). Hausman test is applied to test between fixed effect and random effect (see Table 122). After random effect is chosen as appropriate model, hausman test is applied again to decide between mean group and pooled mean group (see Table 123). CCE-PMG and CS-DL models are applied. According to CCE-PMG model results, cointegration exists between the variables and EKC hypothesis is not confirmed for panel countries (see Table 124). According to CS-DL model results, EKC hypothesis is not confirmed for panel countries (see Table 125).

Variable	CD-test	p-value	Corr	abs(corr)
CO2	1.77	0.077	0.057	0.431
GDP	30.03	0.000	0.963	0.963
GDP2	30.02	0.000	0.963	0.963
EN	18.43	0.000	0.591	0.591

Table 115: Pesaran (2004) test for cross-sectional dependence for Developed Countries (1971 – 1997)

Variable	CD	P-Value
CO2	30.861	0.000
GDP	31.176	0.000
GDP2	31.174	0.000
EN	31.170	0.000

Table 116: Pesaran (2015) test for weak cross-sectional dependence for Developed Countries (1971 – 1997)

Variable	CD-Test	P-Value	Average Joint T	Mean P	Mean abs (p)
CO2	1.766	0.077	27.00	0.06	0.43
GDP	30.03	0.000	27.00	0.96	0.96
GDP2	30.024	0.000	27.00	0.96	0.96
EN	18.434	0.000	27.00	0.59	0.59

Table 117: Pesaran (2004) and Pesaran (2015) test for cross-sectional dependence for Developed Countries (1971 – 1997)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	-2.0725	0.0191	-	-
GDP1	2.1539	0.9844	-5.8985	0.0000
GDP2	2.4605	0.9931	-5.8476	0.0000
EC	-0.5984	0.2748	-8.1445	0.0000

Table 118: Im-Pesaran-Shin UR Results for Developed Countries (1971 – 1997)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	-1.6083	0.0539	-7.0450	0.0000
GDP1	-0.2969	0.3833	-7.8953	0.0000
GDP2	-0.1364	0.4457	-7.7625	0.0000
EC	-1.5628	0.0590	-8.2798	0.0000

Table 119: Levin-Lin-Chu UR Results for Developed Countries (1971 – 1997)

	Level	First Difference	Critical Values		
Variable	CIPS	CIPS	10%	5%	1%
CO2	-2.742	-	-2.21	-2.33	-2.57
GDP	-2.091	-3.757	-2.21	-2.33	-2.57
GDP2	-2.090	-3.740	-2.21	-2.33	-2.57
EN	-3.051	-	-2.21	-2.33	-2.57

Table 120: Pesaran (2007) Panel UR for Developed Countries (1971 – 1997)

	Level			First Difference			Critical Values		
Variable	t-bar	Z-t-bar	P-Value	t-bar	Z-t-bar	P-Value	10%	5%	1%
CO2	-2.242	-1.490	0.068	-4.187	-7.506	0.000	-2.210	-2.330	-2.570
GDP	-2.248	-1.509	0.066	-3.346	-4.905	0.000	-2.210	-2.330	-2.570
GDP2	-2.243	-1.493	0.068	-3.356	-4.935	0.000	-2.210	-2.330	-2.570
EN	-2.881	-3.466	0.000	-	-	-	-2.210	-2.330	-2.570

Table 121: Pesaran (2003) Panel UR for Developed Countries (1971 – 1997)

Chi2(3)	Prob
2.82	0.4195

Table 122: Hausman Test for Fixed Effect vs. Random Effect for Developed Countries (1971 – 1997)

Chi2(3)	Prob
4.93	0.1768

Table 123: Hausman Test for MG vs. PMG for Developed Countries (1971 – 1997)

D.CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
SRR Estimates						
MG						
D.GDP	13.79361	23.56607	0.59	0.558	-32.39503	59.98225
D2.GDP	-27.34135	21.17659	-1.29	0.197	-68.8467	14.164
D.SQ	-0.6529917	1.145117	-0.57	0.569	-2.897379	1.591396
D2.SQ	1.299643	1.026713	1.27	0.206	-0.7126783	3.311963
D.ENC	-0.0089477	0.2336693	-0.04	0.969	-0.4669311	0.4490358
D2.ENC	0.0538146	0.1435071	0.37	0.708	-0.2274541	0.3350833
LRR Estimates						
Pooled						
L.CO2	-0.9032651	0.164308	-5.50	0.000	-1.225303	-0.5812274
GDP	4.715685	8.126694	0.58	0.562	-11.21234	20.64371
SQ	-0.234794	0.4029814	-0.58	0.560	-1.024623	0.555035
ENC	1.135476	0.3345297	3.39	0.001	0.4798099	1.791142
CD Statistic	-1.45	P-Value	0.1463			

Table 124: SRR and LRR Results for CCE-PMG for Developed Countries (1971 – 1997)

CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
MG						
GDP	-84.08684	98.52261	-0.85	0.393	-277.1876	109.0139
SQ	4.008676	4.728724	0.85	0.397	-5.259453	13.2768
EN	-0.6135839	1.922031	-0.32	0.750	-4.380696	3.153528
D.GDP	-2.020389	2.547554	-0.79	0.428	-7.013502	2.972724
LD.GDP	-4.686748	5.1486	-0.91	0.363	-14.77782	5.404322
L2D.GDP	-0.4932242	1.235277	-0.40	0.690	-2.914323	1.927875
D.EN	1.764938	2.457257	0.72	0.473	-3.051198	6.581074
LD.EN	1.389798	1.88212	0.74	0.460	-2.29909	5.078686
L2D.EN	0.8760533	1.407772	0.62	0.534	-1.883129	3.635235
CD Statistic	-1.02	P-Value	0.3091			

Table 125: LRR Results for CS-DL (CCE-MG) for Developed Countries (1971 – 1997)

8.2 Developed Countries CO2-GDP-SQ-ENC Nexus Between 1997 and 2014

Cross-sectional dependency tests are applied. According to cross-sectional dependency tests, there is cross-sectional dependency in panel data (see Table 126, Table 127 and Table 128). First generation panel unit root tests are applied (see Table 129 and Table 130). Since cross-sectional dependency

exists in panel data, second generation panel unit root test are applied (see Table 131 and Table 132). Hausman test is applied to test between fixed effect and random effect (see Table 133). After random effect is chosen as appropriate model, hausman test is applied again to decide between mean group and pooled mean group (see Table 134). CS-ARDL, CCE-PMG and CS-DL models are applied. According to CS-ARDL model results, although cointegration exists between the variables, EKC hypothesis is not confirmed for panel countries (see Table 135). According to CCE-PMG model results, cointegration exists between the variables and EKC hypothesis is not confirmed for panel countries (see Table 136). According to CS-DL model results, EKC hypothesis is not confirmed for panel countries (see Table 137).

Variable	CD-test	p-value	corr	abs(corr)
CO2	17.33	0.000	0.681	0.681
GDP	22.96	0.000	0.902	0.902
SQ	22.94	0.000	0.901	0.901
ENC	11.70	0.000	0.460	0.495

Table 126: Pesaran (2004) test for cross-sectional dependence for Developed Countries (1997 – 2014)

Variable	CD	P-Value
CO2	25.421	0.000
GDP	25.456	0.000
SQ	25.455	0.000
ENC	25.455	0.000

Table 127: Pesaran (2015) test for weak cross-sectional dependence for Developed Countries (1997 – 2014)

Variable	CD-Test	P-Value	Average Joint T	Mean P	Mean abs (p)
CO2	17.33	0.000	18.00	0.68	0.68
GDP	22.961	0.000	18.00	0.90	0.90
SQ	22.937	0.000	18.00	0.90	0.90
ENC	11.697	0.000	18.00	0.46	0.49

Table 128: Pesaran (2004) and Pesaran (2015) test for cross-sectional dependence for Developed Countries (1997 – 2014)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	2.3691	0.9911	-5.5762	0.0000
GDP	-4.2540	0.0000	-	-
SQ	-4.1752	0.0000	-	-
ENC	2.0173	0.9782	-5.7794	0.0000

Table 129: Im-Pesaran-Shin UR Results for Developed Countries (1997 – 2014)

	Level		First Difference	
	Statistics	P-Value	Statistic	P-Value
C02	4.3129	0.9653	-4.4668	0.0000
GDP	-4.4279	0.0000	-	-
SQ	-4.3941	0.0000	-	-
ENC	3.1410	0.9992	-4.8131	0.0000

Table 130: Levin-Lin-Chu UR Results for Developed Countries (1997 – 2014)

	Level	**First Difference**	**Critical Values**		
Variable	**CIPS**	**CIPS**	**10%**	**5%**	**1%**
CO2	-2.506	-	-2.21	-2.34	-2.6
GDP	-0.625	-2.636	-2.21	-2.34	-2.6
SQ	-0.616	-2.631	-2.21	-2.34	-2.6
ENC	-2.395	-	-2.21	-2.34	-2.6

Table 131: Pesaran (2007) Panel UR for Developed Countries (1997 – 2014)

	Level			First Difference			Critical Values		
Variable	t-bar	Z-t-bar	P-Value	t-bar	Z-t-bar	P-Value	10%	5%	1%
CO2	-1.784	-0.158	0.437	-3.137	-4.097	0.000	-2.210	-2.340	-2.600
GDP	-1.402	0.956	0.831	-2.636	-2.639	0.004	-2.210	-2.340	-2.600
SQ	-1.380	1.018	0.846	-2.631	-2.623	0.004	-2.210	-2.340	-2.600
ENC	-1.673	0.165	0.565	-3.413	-4.902	0.000	-2.210	-2.340	-2.600

Table 132: Pesaran (2003) Panel UR for Developed Countries (1997 – 2014)

Chi2(3)	**Prob**
5.16	0.1603

Table 133: Hausman Test for Fixed Effect vs. Random Effect for Developed Countries (1997 – 2014)

Chi2(3)	**Prob**
1.56	0.6688

Table 134: Hausman Test for MG vs. PMG for Developed Countries (1997 – 2014)

CO2	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]	
SRR Estimates						
MG						
L.CO2	0.0916635	0.3228298	0.28	0.776	-0.5410712	0.7243983
L2.CO2	-0.0450127	0.1911582	-0.24	0.814	-0.4196758	0.3296504
L.GDP	-81.39829	99.87384	-0.82	0.415	-277.1474	114.3509
L.SQ	3.731951	4.570679	0.82	0.414	-5.226415	12.69032
L.ENC	0.0969654	0.422804	0.23	0.819	-0.7317153	0.9256461
LRR Estimates						
MG						
LR_CO2	-0.9533491	0.4688588	-2.03	0.042	-1.872295	-0.0344029
LR_ENC	1.323192	1.133478	1.17	0.243	-.8983836	3.544768
LR_GDP	181.4015	231.1606	0.78	0.433	-271.665	634.4681
LR_SQ	-9.182218	11.45932	-0.80	0.423	-31.64207	13.27763
CD Statistic	-1.52	P-Value	0.1292			

Table 135: SRR and LRR Results for CS-ARDL for Developed Countries (1997 – 2014)

D.CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
SRR Estimates						
MG						
D.GDP	-42.29384	49.06348	-0.86	0.389	-138.4565	53.86882
D.SQ	2.117144	2.406189	0.88	0.379	-2.598901	6.833188
D.ENC	0.3857655	0.0788855	4.89	0.000	0.2311528	0.5403783
LRR Estimates						
Pooled						
L.CO2	-0.6910798	0.1443157	-4.79	0.000	-0.9739333	-0.4082262
GDP	-24.12879	41.01917	-0.59	0.556	-104.5249	56.26731
SQ	1.135826	1.949824	0.58	0.560	-2.68576	4.957411
ENC	1.776108	0.8370756	2.12	0.034	0.1354699	3.416746
CD Statistic	-1.77	P-Value	0.0761			

Table 136: SRR and LRR Results for CCE-PMG for Developed Countries (1997 – 2014)

CO2	Coef.	Std. Err.	Z	P>Izl	[95% Conf. Interval]	
MG						
GDP	67.13724	69.76312	0.96	0.336	-69.59595	203.8704
SQ	-3.333865	3.425416	-0.97	0.330	-10.04756	3.379826
ENC	0.1805048	0.0827676	2.18	0.029	0.0182832	0.3427264
D.GDP	-0.0233179	0.2565432	-0.09	0.928	-0.5261333	0.4794975
D.ENC	1.433924	0.1643074	8.73	0.000	1.111888	1.755961
CD Statistic	-1.17	P-Value	0.2404			

Table 137: LRR Results for CS-DL (CCE-MG) for Developed Countries (1997 – 2014)

DISCUSSION

In this study, no long run relationship is found between gross domestic product and carbon dioxide emissions. All the countries in the sample of developing and developed countries did not pass bounds test for emissions-growth nexus except UK which did not pass Johansen cointegration test instead of bounds test. No long run relationship between emissions and growth means that related countries are likely to maintain their growth levels without causing environmental degradation. The EKC hypothesis is examined in this study for developed and developing countries. Nonlinear ARDL methodology is also applied since generally in the literature only symmetric relationship between emissions and growth is examined. ARDL is the common methodology in environmental Kuznets literature according to Shahbaz and Sinha (2019). ARDL model is also used in this study to compare the results of this study with the similar studies in the literature.

For coal consumption, long run relationship is found between growth and coal consumption for New Zealand and Finland. Finding is important since countries like Finland is an experiment for bigger countries such as USA. Countries like USA can apply similar policies that are carried out by Finland. Current market mechanisms are in favor of renewable energy generation systems over fossil fuel systems such as coal. Renewable energy prices are falling and since consumers are becoming more aware of climate change, investing in coal-based energy plants are getting riskier. Since risk increases, investors are becoming less likely to invest in new coal-based energy plants. Current trend shows that closure of coal-based energy plants will exceed the opening of new coal-based energy plants. Energy generation from coal will not finish in the short run but energy generation from coal will likely decrease significantly and current growth levels of developed and developing countries are in favor of reduction of coal consumption. Finding inverted U curve between coal consumption and growth is important since coal consumption alone is responsible for 30% of energy related carbon dioxide emissions. General trend in the world is to increase growth levels for developed and

developing countries. Further investigation of coal consumption-growth nexus carries importance since the only study in the literature for coal consumption-growth nexus belongs to Hao et al. (2016) except this study.

For the effect of Kyoto protocol, CS-ARDL, CCE-PMG and CS-DL methodologies are all used although results of Hausman test are in favor of random effect model since Hausman test may not be sensitive to cross-sectional dependency in the data and the studies in the literature used CS-ARDL, CCE-PMG and CS-DL when Hausman test were in favor of random effect model in the case of cross-sectional dependency in the data. 1997 date is chosen as the beginning of the effect of Kyoto protocol in this study. There are studies in the literature that chose 1997 date as the beginning of the effect of Kyoto protocol and there are studies that chose different dates other than 1997. Commencement dates are different in the literature for Kyoto protocol. The results of this study for the effect of Kyoto protocol are in line with the current literature that Kyoto protocol did not decrease the emission levels of the related countries with the protocol. Most up to date studies in the literature also stated Kyoto protocol only prevented the emissions to become worse that would have happened in no-Kyoto protocol scenario. Although studies stated the emissions would be worse in no-Kyoto scenario, there are other factors such as rising of average temperatures around the world might have helped the emissions not to get worse. The overall economic recession in the world is another factor might have helped the emissions not to get worse. Overall emissions continued to rise in the case of Kyoto protocol.

CONCLUSION

The EKC hypothesis is examined in this study for developed and developing countries.

Main findings of the study are;

- The EKC hypothesis is not confirmed for developing countries which are Argentina, Egypt, Ghana, Iran, Kenya, Malaysia and Nigeria.
- The EKC hypothesis is not confirmed for developed countries which are Austria, Belgium, Finland, Sweden, Denmark, Spain and UK.
- Unidirectional causality from ENC to CO2 is found for Denmark and unidirectional causality from CO2 to ENC is found for UK.
- Coal consumption environmental Kuznets curve is confirmed for New Zealand and Finland.
- Effect of the Kyoto Protocol is not confirmed for developed and developing countries since the EKC hypothesis is not confirmed and no significant relationship is found between GDP and CO2.

Our results are in line for rejecting the EKC hypothesis for developing countries with Begum et al. (2015) and Gill et al. (2017) for Malaysia, Oyinlola (2010) and Akpan and Chuku (2011) for Nigeria, Asghari (2012) and Saboori and Soleymani (2011) for Iran, Twerefou, Adusah-Poku and Bekoe (2016), Appiah, Du, Musah and Afriyie (2017) and Muhammad, Solarin and Ozturk (2016) for Ghana, and Ibrahiem (2016), El-aasar and Hanafy (2018) and Alaoui (2017) for Egypt. Al-Mulali, Solarin and Ozturk (2016) confirmed the EKC hypothesis in Kenya which is the opposite result to our findings in Kenya.

For Sweden, Urban and Nordensvärd (2018) and Ankarhem (2005) confirmed the EKC hypothesis. Baek (2015) did not confirm EKC for Sweden. Iwata, Okada and Samreth (2012) rejected EKC for Sweden. Pilatowska, Wlodarczyk and Zawada (2015) confirmed EKC for Sweden. This study confirmed no EKC for Sweden.

For Finland, Urban and Nordensvärd (2018) confirmed EKC for per capita CO2 emissions but not for total CO2 emissions. Baek (2015) did not confirm EKC for Finland. Kunnas and Myllyntaus (2007) did not confirm EKC for Finland. Iwata, Okada and Samreth (2012) reject EKC for Finland. Pilatowska, Wlodarczyk and Zawada (2015) confirmed EKC for Finland. This study did not confirm EKC for Finland.

For Denmark, Baek (2015) did not confirm EKC. Pilatowska, Wlodarczyk and Zawada (2015) confirmed EKC for Denmark. This study did not confirm EKC for Denmark.

For UK, Bruyn, Bergh and Opschoor (1998) and Acaravci and Ozturk (2010) did not confirm EKC. Sephton and Mann (2016) and Fosten, Morley and Taylor (2012) confirmed EKC for UK. Iwata, Okada and Samreth (2012) reject EKC for UK. Pilatowska, Wlodarczyk and Zawada (2015) confirmed EKC for UK. This study did not confirm EKC for UK.

For Spain, Roca, Padilla, Farre and Galletto (2001) and Esteve and Tamarit (2012) did not confirm EKC. Iwata, Okada and Samreth (2012) reject EKC for Spain. Balaguer and Cantavella (2016) confirmed EKC for Spain. Sephton and Mann (2013) and Esteve and Tamarit (2012b) confirmed EKC for Spain. This study did not confirm EKC for Spain.

For Belgium, Iwata, Okada and Samreth (2012) reject EKC. Pilatowska, Wlodarczyk and Zawada (2015) confirmed EKC for Belgium. This study did not confirm EKC for Belgium.

Hao et al. (2016) confirmed coal consumption environmental Kuznets curve as this study confirmed in New Zealand and Finland. The study of Hao et al. (2016) is the only study in the literature for coal consumption environmental Kuznets curve. This study contributes to the current literature by verifying coal consumption environmental Kuznets curve for New Zealand and Finland.

Almer and Winkler (2017), Maamoun (2019) and Grunewald and Martinez-Zarzoso (2016) examined the effect of the Kyoto Protocol by using different methodologies. Maamoun (2019) used the generalized synthetic control method, Almer and Winkler (2017) used the synthetic control method and Grunewald and Martinez-Zarzoso (2016) used a difference-in-differences estimator method to analyze the sample countries in their studies. Maamoun (2019) and Grunewald and Martinez-Zarzoso (2016) found that the Kyoto Protocol was effective for preventing further emissions. Almer and Winkler (2017) found that there is no difference in emissions between the Kyoto Protocol scenario and no-Kyoto Protocol scenario. Almer and Winkler (2017), Maamoun (2019) and Grunewald and Martinez-Zarzoso (2016) confirmed that there were no reduction in emissions during the treatment of the Kyoto Protocol. This study confirmed that Kyoto protocol did not reduce the emissions and the results of this study are in line with the most current literature for the effect of Kyoto Protocol on emission levels.

For general policy implications for developing and developed countries, countries should increase efficiency of energy technologies and maintain policies to increase alternatives to replace oil usage. Incentives should be provided to increase the number of electric vehicles in the transport sector. The share of renewable energy consumption should be increased in the transport sector. The share of renewable energy consumption should be increased in the household sector as well. Energy efficiency policy for air transport should be maintained. Improving home insulation should be continued to contribute to overall energy efficiency policy. Fuel tax rates should be adjusted to contribute to overall energy efficiency policy. Vehicle incentive programs should be maintained to replace old cars with the new ones to decrease the average emission levels per car. Percentage of electricity consumption should be increased in the transport sector. Investment in energy conservation and emission reduction policies and increasing the use of natural gas in the transport sector should be maintained.

For future research directions, nonlinear relationships for EKC hypothesis may be analyzed since there are still gaps in the literature for nonlinear relationships for EKC hypothesis. Coal consumption environmental Kuznets curve may be analyzed for different countries and different regions by existing or new methodologies in the literature. Effect of external debt on emission levels within the EKC hypothesis may be analyzed in the future research especially for USA and China since effect of external debt on emission levels is not analyzed in the current literature. The limitation of this study is that further protocols may be analyzed such as Paris Agreement.

For ontological and epistemological sides of this study, this study adopts a realistic ontology. Ontology is concerned with what constitutes valid knowledge and how we can obtain it. Epistemology is concerned with what constitutes reality and how we can understand existence. Purpose of this study to investigate the impact of gross domestic product and energy consumption on carbon dioxide emissions and the impact of Kyoto protocol on carbon dioxide emissions. The reality of the current world trend is countries are aiming to increase gross domestic product continuously and these countries are increasing energy consumption mainly in terms of fossil fuel resources to meet the energy demand to grow further. This study tests that whether increase and decrease in carbon dioxide emissions could be explained in terms of gross domestic product and energy consumption. For realistic approach, it means the truth can be captured if the right methods are used. Epistemological stance of this study is objectivism. In objectivist reality, there are universal principles and facts which are independent of any consciousness. In this study, relationships between carbon dioxide emissions, gross domestic product and energy consumption are examined by econometric methodologies by being separate from researchers. Positivism is the theoretical perspective of this study. Positivism takes into consideration only observable facts to reach knowledge. This study investigated the relationships between emission, growth and energy consumption and investigated these relationships with econometric analysis by data.

Sample	Variables	Methodology	Time Period	Results
Argentina	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Egypt	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Ghana	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Iran	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Kenya	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Malaysia	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC
Nigeria	CO2-GDP-SQ	ARDL, NARDL, Bootstrap ARDL	1971 – 2014	No EKC

Table 138: Main Findings-I

Sample	Variables	Methodology	Time Period	Results
Austria	CO2-GDP-SQ	ARDL, NARDL, Bootstrap ARDL	1960 – 2014	No EKC
Belgium	CO2-GDP-SQ	ARDL, NARDL, Bootstrap ARDL	1960 - 2014	No EKC
Sweden	CO2-GDP-SQ-ENC	ARDL, NARDL, Bootstrap ARDL	1960 - 2014	No EKC
Finland	CO2-GDP-SQ-ENC	Bootstrap ARDL	1960 - 2014	No EKC
Denmark	CO2-GDP-ENC	ARDL, Bootstrap ARDL, Toda and Yamamoto Granger Non-Causality Test	1960 - 2014	No EKC
Denmark	CO2-GDP-SQ-ENC	ARDL, Bootstrap ARDL	1960 - 2014	No EKC
Spain	CO2-GDP-ENC	ARDL, Bootstrap ARDL, Toda and Yamamoto Granger Non-Causality Test	1960 - 2014	No EKC
Spain	CO2-GDP-SQ-ENC	ARDL, Bootstrap ARDL	1960 - 2014	No EKC
UK	CO2-GDP-ENC	Johansen Cointegration Test, IRRA Analysis and VDDA Analysis	1960 - 2014	No EKC
UK	CO2-GDP-SQ-ENC	Johansen Cointegration Test	1960 - 2014	No EKC
New Zealand	CS-GDP-SQ	ARDL, Bootstrap ARDL, ARDL Dynamic Multiplier Model	1980 - 2015	Coal Consumption EKC is confirmed
Finland	CS-GDP-SQ	ARDL, Bootstrap ARDL, ARDL Dynamic Multiplier Model	1980 - 2013	Coal Consumption EKC is confirmed
Developing Countries	CO2-GDP-SQ-ENC	CS-DL(CCE-MG)	1971 - 1997	No Effect of Kyoto Protocol
Developing Countries	CO2-GDP-SQ	CS-ARDL, CCE-PMG	1971 - 1997	No Effect of Kyoto Protocol
Developing Countries	CO2-GDP-SQ-ENC	CS-ARDL, CCE-PMG, CS-DL(CCE-MG)	1997 - 2014	No Effect of Kyoto Protocol
Developed Countries	CO2-GDP-SQ-ENC	CCE-PMG, CS-DL(CCE-MG)	1971 - 1997	No Effect of Kyoto Protocol
Developed Countries	CO2-GDP-SQ-ENC	CS-ARDL, CCE-PMG, CS-DL(CCE-MG)	1997 - 2014	No Effect of Kyoto Protocol

Table 139: Main Findings-II

REFERENCES

Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO2 emissions and economic growth in Europe. *Energy*, *35*(12), 5412–5420. https://doi.org/10.1016/j.energy.2010.07.009

Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., & Liu, Y. (2016). Carbon emissions , energy consumption and economic growth : An aggregate and disaggregate analysis of the Indian economy. *Energy Policy*, *96*, 131–143. https://doi.org/10.1016/j.enpol.2016.05.032

Aichele, R., & Felbermayr, G. (2013). The Effect of the Kyoto Protocol on Carbon Emissions. *Journal of Policy Analysis and Management*, *32*(4), 731–757. https://doi.org/10.1002/pam

Akpan, U. F., & Chuku, A. (2011). Economic Growth and Environmental Degradation in Nigeria: Beyond the Environmental Kuznets Curve. *MPRA Paper*, (31241).

Al-Mulali, U., Solarin, S. A., & Ozturk, I. (2016). Investigating the presence of the environmental Kuznets curve (EKC) hypothesis in Kenya: an autoregressive distributed lag (ARDL) approach. *Natural Hazards*, *80*(3), 1729–1747. https://doi.org/10.1007/s11069-015-2050-x

Alaoui, A. E. (2017). What is the relationship between environmental quality, economic growth and free trade? *International Journal of Social Sciences and Education Research*, *3*(1), 124–144. https://doi.org/10.24289/ijsser.283594

Almer, C., & Winkler, R. (2017). Analyzing the effectiveness of international environmental policies : The case of the Kyoto Protocol. *Journal of Environmental Economics and Management*, *82*, 125–151. https://doi.org/10.1016/j.jeem.2016.11.003

Ankarhem, M. (2005). A Dual Assessment of the Environmental Kuznets Curve : The Case of Sweden. *The S-WoPEc Working Paper Collection*, (660). Retrieved from http://www.usbe.umu.se/404?contentId=52945&languageId=3&assetKey=ues660

Appiah, K., Du, J., Musah, A. I., & Afriyie, S. (2017). Investigation of the Relationship between Economic Growth and Carbon Dioxide (CO2) Emissions as Economic Structure Changes: Evidence from Ghana. *Resources and Environment*, *7*(6), 160–167. https://doi.org/10.5923/j.re.20170706.02

Asghari, M. (2012). Environmental Kuznets Curve and Growth Source in Iran. *Panoeconomicus*, *5*(September 2010), 609–623. https://doi.org/10.2298/PAN1205609A

Azlina, A. A., Hook, S., Hashim, N., & Mustapha, N. (2014). Dynamic linkages among transport energy consumption , income and CO 2 emission in Malaysia. *Energy Policy*, *73*, 598–606. https://doi.org/10.1016/j.enpol.2014.05.046

Baek, J. (2015). Environmental Kuznets curve for CO2 emissions : The case of Arctic countries. *Energy Economics*, *50*, 13–17. https://doi.org/10.1016/j.eneco.2015.04.010

Balaguer, J., & Cantavella, M. (2016). Estimating the environmental Kuznets curve for Spain by considering fuel oil prices (1874 – 2011), *60*, 853–859.

Banerjee, A., Dolado, J. J., & Mestre, R. (1998). Error-correction mechanism tests for

cointegration in a single-equation framework b. *Journal of Time Series Analysis*, *19*(3).

Begum, R. A., Sohag, K., Abdullah, S. M. S., & Jaafar, M. (2015). CO 2 emissions , energy consumption , economic and population growth in Malaysia. *Renewable and Sustainable Energy Reviews*, *41*, 594–601. https://doi.org/10.1016/j.rser.2014.07.205

Benavides, M., Ovalle, K., Torres, C., & Vinces, T. (2017). Economic Growth , Renewable Energy and Methane Emissions : Is there an Enviromental Kuznets Curve in Austria ? *International Journal of Energy Economics and Policy*, *7*(1), 259–267.

Boutabba, M. A. (2014). The impact of fi nancial development , income , energy and trade on carbon emissions : Evidence from the Indian economy Mohamed Amine Boutabba ∗. *Economic Modelling*, *40*, 33–41. https://doi.org/10.1016/j.econmod.2014.03.005

Bruyn, S. M. De, Bergh, J. C. J. M. Van Den, & Opschoor, J. B. (1998). Economic growth and emissions : reconsidering the empirical basis of environmental Kuznets curves, *25*, 161–175.

Chudik, A., Mohaddes, K., Pesaran, M. H., & Raissi, M. (2016). Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors. *Advances in Econometrics*, *36*, 85–135. https://doi.org/10.1108/S0731-905320160000036013

Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, *188*(2), 393–420. https://doi.org/10.1016/j.jeconom.2015.03.007

Chuku, A. (2011). Economic development and environmental quality in Nigeria: is there an environmental Kuznets curve? *MPRA Paper*, (30195).

Day, K. M., & Grafton, R. Q. (2003). Growth and the Environment in Canada : An Empirical Analysis. *Canadian Journal of Agriculture Economics*, *51*, 197–216.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, *49*(4), 1057–1072.

Dogan, E., & Turkekul, B. (2016). CO2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA. *Environmental Science and Pollution Research*, *23*(2), 1203–1213. https://doi.org/10.1007/s11356-015-5323-8

El-aasar, K. M., & Hanafy, S. A. (2018). Investigating the Environmental Kuznets Curve Hypothesis in Egypt : The Role of Renewable Energy and Trade in Mitigating GHGs. *International Journal of Energy Economics and Policy*, *8*(3), 177–184.

Esteve, V., & Tamarit, C. (2012a). Is there an environmental Kuznets curve for Spain ? Fresh evidence from old data. *Economic Modelling*, *29*(6), 2696–2703. https://doi.org/10.1016/j.econmod.2012.08.016

Esteve, V., & Tamarit, C. (2012b). Threshold cointegration and nonlinear adjustment between CO 2 and income : The Environmental Kuznets Curve in Spain , 1857 – 2007. *Energy Economics*, *34*(6), 2148–2156. https://doi.org/10.1016/j.eneco.2012.03.001

Fosten, J., Morley, B., & Taylor, T. (2012). Dynamic misspecification in the environmental Kuznets curve : Evidence from CO 2 and SO 2 emissions in the United Kingdom.

Ecological Economics, *76*, 25–33. https://doi.org/10.1016/j.ecolecon.2012.01.023

Gill, A. R., Viswanathan, K. K., & Hassan, S. (2017). A test of environmental Kuznets curve (EKC) for carbon emission and potential of renewable energy to reduce green house gases (GHG) in Malaysia. *Environment, Development and Sustainability*, *20*(3), 1103–1114. https://doi.org/10.1007/s10668-017-9929-5

Grunewald, N., & Martinez-Zarzoso, I. (2016). Did the Kyoto Protocol fail ? An evaluation of the effect of the Kyoto Protocol on CO2 emissions Environment and Development Development Economics : *Environment and Development Economics*, *21*(1), 1–22. https://doi.org/10.1017/S1355770X15000091

Halkos, G. E., & Tzeremes, N. G. (2014). Measuring the effect of Kyoto protocol agreement on countries ' environmental efficiency in CO 2 emissions : an application of conditional full frontiers. *Journal of Productivity Analysis*, *41*, 367–382. https://doi.org/10.1007/s11123-013-0343-1

Hao, Y., Liu, Y., Weng, J. H., & Gao, Y. (2016). Does the Environmental Kuznets Curve for coal consumption in China exist? New evidence from spatial econometric analysis. *Energy*, *114*, 1214–1223. https://doi.org/10.1016/j.energy.2016.08.075

Haq, I. ul, Zhu, S., & Shafiq, M. (2016). Empirical investigation of environmental Kuznets curve for carbon emission in Morocco. *Ecological Indicators*, *67*, 491–496. https://doi.org/10.1016/j.ecolind.2016.03.019

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, *46*(6), 1251–1271.

He, J., & Richard, P. (2010). Environmental Kuznets curve for CO2 in Canada. *Ecological Economics*, *69*(5), 1083–1093. https://doi.org/10.1016/j.ecolecon.2009.11.030

Ibrahiem, D. M. (2016). Environmental Kuznets curve: an empirical analysis for carbon dioxide emissions in Egypt. *International Journal of Green Economics*, *10*(2), 136–150. https://doi.org/10.1504/IJGE.2016.10001598

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

Iwata, H., Okada, K., & Samreth, S. (2012). Empirical study on the determinants of CO2 emissions: evidence from OECD countries. *Applied Economics*, *44*(27), 3513–3519. https://doi.org/10.1080/00036846.2011.577023

Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models Author (s): Søren Johansen Published by : Econometric Society Stable URL : http://www.jstor.org/stable/2938278 REFERENCES Linked references are available, *59*(6), 1551–1580.

Kanjilal, K., & Ghosh, S. (2013). Environmental Kuznet ' s curve for India : Evidence from tests for cointegration with unknown structural breaks. *Energy Policy*, *56*, 509–515. https://doi.org/10.1016/j.enpol.2013.01.015

Kharbach, M., & Chfadi, T. (2017). CO 2 emissions in Moroccan road transport sector :

Divisia , Cointegration , and EKC analyses. *Sustainable Cities and Society*, *35*(July), 396–401. https://doi.org/10.1016/j.scs.2017.08.016

Kumazawa, R., & Callaghan, M. S. (2012). The effect of the Kyoto Protocol on carbon dioxide emissions. *Journal of Economics and Finance*, *36*, 201–210. https://doi.org/10.1007/s12197-010-9164-5

Kunnas, J., & Myllyntaus, T. (2007). The Environmental Kuznets Curve Hypothesis and Air Pollution in Finland The Environmental Kuznets Curve Hypothesis and Air Pollution in Finland, *5522*. https://doi.org/10.1080/03585520701435970

Kuznets, S. (1955). Economic Growth and Income Inequality. *The American Economic Review*, *45*(1), 292–302. https://doi.org/10.1596/978-0-8213-7318-7

Lau, L., Choong, C., & Eng, Y. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia : Do foreign direct investment and trade matter ? *Energy Policy*, *68*, 490–497. https://doi.org/10.1016/j.enpol.2014.01.002

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24. https://doi.org/10.1016/S0304-4076(01)00098-7

Maamoun, N. (2019). The Kyoto protocol : Empirical evidence of a hidden success. *Journal of Environmental Economics and Management*, *95*, 227–256. https://doi.org/10.1016/j.jeem.2019.04.001

Mert, M., & Çağlar, A. E. (2017). Kyoto Protokolünün Karbon Emisyonu Üzerine Etkisi : Kırılmalı Panel Birim Impact of Kyoto Protocol on Carbon Emissions : An Application of Panel Unit Root Tests with Structural Breaks. *Business and Economics Research Journal*, *8*(4), 661–672.

Muhammad, S., Solarin, S. A., & Ozturk, I. (2016). *Environmental Kuznets curve hypothesis and the role of globalization in selected African countries*.

Olusegun, O. A. (2009). Economic growth and environmental quality in nigeria does the environmental kuznets curve hypothesis hold.pdf. *Environmental Research Journal*, *3*(1), 14–18.

Oyinlola, M. A. (2010). Does the Level of Economic Growth Influence Environmental Quality in Nigeria : A Test of Environmental Kuznets Curve (EKC) Hypothesis ? *Pakistan Journal of Social Science*, *7*(4), 325–329. https://doi.org/10.3923/pjssci.2010.325.329

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *Iza*, (1240, (August)), 1–42. Retrieved from http://www.dspace.cam.ac.uk/handle/1810/446

Pesaran, M. H. (2015). Testing Weak Cross-Sectional Dependence in Large Panels. *Econometric Reviews*, *34*(6–10), 1089–1117. https://doi.org/10.1080/07474938.2014.956623

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. https://doi.org/10.1002/jae.616

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, *94*(446), 621–634. https://doi.org/10.1080/01621459.1999.10474156

Pilatowska, M., Wlodarczyk, A., & Zawada, M. (2015). CO2 emissions, energy consumption and economic growth in the EU countries: Evidence from threshold cointegration analysis. *2015 12th International Conference on the European Energy Market (EEM)*, 1–5. https://doi.org/10.1109/EEM.2015.7216646

Roca, J., Padilla, E., Farre, M., & Galletto, V. (2001). Economic growth and atmospheric pollution in Spain : discussing the environmental Kuznets curve hypothesis, *39*, 85–99.

Saboori, B, & Soleymani, A. (2011). CO 2 emissions , economic growth and energy consumption in Iran : A co- integration approach. *International Journal of Environmental Sciences*, *2*(1), 44–53. https://doi.org/10.6088/ijes.00202010005

Saboori, Behnaz, & Sulaiman, J. (2013). Environmental degradation , economic growth and energy consumption : Evidence of the environmental Kuznets curve in Malaysia. *Energy Policy*, *60*, 892–905. https://doi.org/10.1016/j.enpol.2013.05.099

Saboori, Behnaz, Sulaiman, J., & Mohd, S. (2012). Economic growth and CO2emissions in Malaysia: A cointegration analysis of the Environmental Kuznets Curve. *Energy Policy*, *51*, 184–191. https://doi.org/10.1016/j.enpol.2012.08.065

Sephton, P., & Mann, J. (2013). Further evidence of an Environmental Kuznets Curve in Spain. *Energy Economics*, *36*, 177–181. https://doi.org/10.1016/j.eneco.2013.01.001

Sephton, P., & Mann, J. (2016). Compelling Evidence of an Environmental Kuznets Curve in the United Kingdom. *Environmental and Resource Economics*, 301–315. https://doi.org/10.1007/s10640-014-9871-z

Shahbaz, M., Jalil, A., & Dube, S. (2010). Environmental Kuznets curve (EKC): Times series evidence from Portugal Muhammad. *MPRA Paper*, (27443).

Shahbaz, M., & Sinha, A. (2019). Environmental Kuznets curve for CO2 emissions: a literature survey. *Journal of Economic Studies*, *46*(1), 106–168. https://doi.org/10.1108/JES-09-2017-0249

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). https://doi.org/https://doi.org/10.1007/978-1-4899-8008-3_9

Sulaiman, J., Azman, A., & Saboori, B. (2013). The Potentialof Renewable Energy : Using The Environmental Kuznets Curve Model. *American Journal of Environmental Science*, *9*(2), 103–112. https://doi.org/10.3844/ajessp.2013.103.112

Taghvaee, V. M., & Parsa, H. (2015). Economic growth and environmental pollution in Iran: Evidence from manufacturing and services sectors. *MPRA Paper*, (67885).

Tiwari, A. K., Shahbaz, M., & Hye, Q. M. A. (2013). The environmental Kuznets curve and the role of coal consumption in India : Cointegration and causality analysis in an open economy. *Renewable and Sustainable Energy Reviews*, *18*, 519–527. https://doi.org/10.1016/j.rser.2012.10.031

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, *66*(1–2), 225–250. https://doi.org/10.1016/0304-4076(94)01616-8

Twerefou, D. K., Adusah-Poku, F., & Bekoe, W. (2016). An empirical examination of the Environmental Kuznets Curve hypothesis for carbon dioxide emissions in Ghana: an ARDL approach. *Environmental & Socio-Economic Studies*, *4*(4), 1–12. https://doi.org/10.1515/environ-2016-0019

Urban, F., & Nordensvärd, J. (2018). Low Carbon Energy Transitions in the Nordic Countries : Evidence from the Environmental Kuznets Curve. *Energies*, *11*(9), 2209. https://doi.org/10.3390/en11092209

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ETHICS COMMITEE APPROVAL

YAKIN DOĞU ÜNİVERSİTESİ

BİLİMSEL ARAŞTIRMALAR ETİK KURULU

18.09.2019

Dear Emrah Beşe

Your project **"Empirical Relationship Between Carbon Dioxide Emissions, Gross Domestic Product and Energy Consumption for Developing and Developed Countries, and Effect of Kyoto Protocol on Developing and Developed Countries"** has been evaluated. Since only secondary data will be used the project it does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Assoc. Prof. Dr. Direnç Kanol

Rapporteur of the Scientific Research Ethics Committee

Direnc Kanol