“The Impact of Financial Development, Income, Energy Consumption, Trade Openness on Carbon Emissions in Jordan”

"أثر التطور المالي، الدخل، استهلاك الطاقة، الانفتاح التجاري على انبعاثات ثاني أكسيد الكربون في الأردن"

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2016

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Dedication

This thesis is dedicated to:

My parents, who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve,

My fiancé, Samer, who has been a constant source of support and encouragement during the challenges of process. I am truly thankful for having you in my life,

My beloved brothers and sisters and all my family, the symbol of love and giving,

My many friends who have supported me throughout the process. I will always appreciate all they have done,

To my distinguished teachers those who lightened my way with their knowledge.

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Above all I thank God, my Creator and my Master, the almighty for his giving me the motivation and patience in this way.

Abstract

This thesis aims to study the effect of financial development, income, energy consumption, and trade openness on carbon emissions in Jordan during the period 1980 to 2011. The importance of analyzing the effect of these factors on CO_2 (carbon dioxide) emissions, also known as "greenhouse gases emissions", stems from the underlying danger of these emissions. Recently, the negative effects of these emissions on climate change have become a hot topic around the world. More alarmingly, the United Nations Environment Program (UNEP, 2014) has announced that global temperature has increased by two degrees Celsius, these changes might be irreversible.

In order to reduce the effects of these emissions, they must be controlled to create a balance by the middle or the end of this century. This study attempts to identify some factors affecting the CO_2 emissions, and the degree of the influence of each factor. This would help in identifying the maximum amount of carbon dioxide that can be emitted into the atmosphere, but in the accepted limits of temperature rise beyond 2020.

Jordan was one of the first countries that took actions regarding the subject of the impact of carbon emissions. Jordan signed the climate change agreement in 1992, and ratified the Kyoto Protocol in 1997. Jordan's second report on the climate change for 2000 mentioned that the total greenhouse gas emissions are equivalent to 20 million tons of carbon dioxide. The energy sector, which accounted to about 27% of these emissions, takes lead. It is closely followed by the transport sector which accounted to about 20%. The third most influential sector is the waste sector which accounted for about 13% of the emissions.

Tracking the timeline of GDP shows CO_2 emissions have taken an upward trend during the period of 1980-2011, except for the period between 1988 and 1991 where GDP level declined as a result of the economic crisis to the Jordanian economy which was a result of the deterioration of exchange rate during that period.

This study empirically examines the long-run and short-run dynamic relationship between financial development, income, energy consumption, trade openness and carbon emissions. The study tests the existence and direction of a causal relationship between these variables using time series data were obtained from World Bank and UNCTAD databases. Finally, the study considers the validity of EKC (Environmental Kuznets Curves) hypothesis in Jordan for the period 1980–2011.

The results of the bound F-test for co-integration test supports the existence of a long-run relationship between per capita energy consumption, per capita income, the square of per capita income, trade openness, financial development and per capita carbon emissions. Findings also indicate that a per capita carbon emission have a positive relationship with foreign trade to GDP ratio and with energy consumption, while financial development, has a negative and significant impact on per capita carbon emissions in the long- run. The results also support the validity of EKC hypothesis in Jordan's economy, which means that the level of CO_2 emissions in Jordan increases with income during the initial stage, continues until a stabilization point, and then emissions start declining.

Moreover, using error-correction depending on the Granger causality test, the study finds a causal relationship between the variables. In particularly, their exists a unidirectional long-run causality from per capita GDP, the square of per capita GDP, per capita energy use and financial development to per capita carbon emissions.

ملخص

تهدف هذه الدراسة الى تحليل أثر التطور المالي، الدخل، استهلاك الطاقة، والانفتاح التجاري على انبعاثات ثاني أكسيد الكربون في الأردن. وتعود أهمية دراسة أثر هذه العوامل على انبعاثات الكربون والتي تعرف "بانبعاثات الغازات الدفيئة" بسبب الخطر الكامن وراء هذه الانبعاثات. حديثا، أصبح التأثير السلبي لهذه الانبعاثات على التغير المناخي من المواضيع الهامة في جميع أنحاء العالم، والأكثر إزعاجا، حيث أن برنامج الأمم المتحدة للبيئة أعلن أنه بسبب هذه الانبعاثات ارتفعت درجة حرارة العالم بمقدار درجتين مئويتين، وقد تكون هذه التغيرات لا رجعة فيها.

ومن أجل الحد من انبعاثات الكربون، دعت الحاجة إلى التحكم فيها من خلال خلق تعادل في تأثير الانبعاث الكربوني العالمي بحلول منتصف أو أواخر القرن الحالي. تحاول هذه الدراسة التعرف على العوامل المؤثرة على انبعاثات ثاني أكسيد الكربون، ودرجة تأثير كل منها. ويساعد ذلك في التعرف على أكبر قدر ممكن من ثاني أكسيد الكربون الذي يمكن أن ينبعث في الغلاف الجوي، ولكن ضمن الحدود المقبولة من ارتفاع درجة الحرارة إلى ما بعد عام 2020.

كان الأردن من الدول الرائدة التي أخذت موضوع تأثير الانبعاثات الكربونية على محمل الجد. حيث وقع الأردن على اتفاقية التغير المناخي في العام 1992 وصادق على برتوكول كيوتو في العام 1997. أشار تقرير الأردن الثاني في مجال التغير المناخي للعام 2000 إلى أن إجمالي انبعاثات (غازات الدفيئات) هي 20 مليون طن من مكافئ ثاني أكسيد الكربون والتي توزعت على الشكل التالي: 27% منبعثة من قطاع الطاقة ،20% من قطاع النقل و 13% من الانبعاثات الصادرة عن قطاع النفايات.

ومن خلال تتبع المسار الزمني للناتج المحلي الإجمالي في الأردن، يتضح أنه قد اتخذ اتجاها بوتيرة تصاعدية خلال فترة الدراسة 1980-2011، باستثناء الفترة الممتدة من 1988 إلى 1991 التي شهدت تراجعا في مستوى الناتج المحلي الإجمالي أعقاب الأزمة الاقتصادية التي تعرض لها الاقتصاد الأردني؛ نتيجة تدهور سعر الصرف خلال تلك الفترة.

وأخيرا، من أجل السيطرة على انبعاثات ثاني أكسيد الكربون في قطاع النقل، سعت الحكومة الأردنية إلى اتخاذ العديد من الإجراءات من أجل الحد من الانبعاثات الناتجة عن هذا القطاع، وكان من تلك الإجراءات التحول إلى استخدام أنظمة السكك الخفيفة الكهربائية، تخفيض الرسوم الجمركية وضريبة المبيعات وأي رسوم أخرى على المركبات ذات المحركات الصغيرة.

تهدف هذه الدراسة إلى فحص العلاقة الديناميكية طويلة وقصيرة الأجل بين التطور المالي، الدخل، استهلاك الطاقة، الانفتاح التجاري وانبعاثات ثاني أكسيد الكربون. علاوة على ذلك، تقوم الدراسة باختبار وجود واتجاه العلاقة السببية بين هذه المتغيرات، وأخيرا، تفحص فرضيات منحنى كوزنتش البيئي للفترة 1980 إلى 2011. تم إستخدام طريقة الانحدار الذاتي لفترات الإبطاء الموزعة بأسلوب اختبارالحدود، استخدام متجه تصحيح الخطأ، بالإضافة إلى اختبار سكون كل متغير من متغيرات الدراسة.

اتضح من نتائج التحليل وجود علاقة طويلة الأجل بين التطور المالي، الدخل، استهلاك الطاقة، الانفتاح التجاري وانبعاثات ثاني أكسيد الكربون. تشير النتائج إلى أن لنصيب الفرد من إنبعاثات ثاني أكسيد الكربون علاقة إيجابية مع التجارة الخارجية إلى الناتج المحلي الإجمالي واستهلاك الطاقة. أما التطور المالي،فتشير النتائج إلى أن له تأثير سلبي وكبير على انبعاثات ثاني أكسيد الكربون للفرد الواحد في المدى الطويل. وكما تدعم النتائج صحة فرضية منحنى كوزنتش البيئي في الإقتصاد الأردني، وهذا يعني أن مستوى انبعاثات الكربون تزيد في البداية مع الدخل، حتى تصل إلى نقطة استقراره، ثم بعد ذلك تأخذ بالتناقص.

بالإضافة إلى ذلك تستكشف هذه الدراسة العلاقة السببية بين المتغيرات باستخدام اختبار السببية بين المتغيرات، حيث أظهرت نتائج هذا الإختبار وجود علاقة سببية أحادية الاتجاه في المدى الطويل من المتغيرات المستقلة المتمثلة في الدخل، التطور المالي، استهلاك الطاقة، والانفتاح التجاري إلى انبعاثات ثاني أكسيد الكربون.

Abbreviations

ADF: Augmented Dichey-Fuller

ADF-GLS: Augmented Dichey-Fuller Generalized Least Square

AIC: Akaike information criterion

ARDL: autoregressive distributed lag

CBJ: Central Bank of Jordan

CO_2: Carbon Dioxide

CUSUM: Cumulative Sum

CUSUMSQ: Cumulative Sum of squares

ECM: Error Correction Model

ECT: Error Correction Term

EKC: Environmental Kuznets Curves

FDI: Foreign Direct Investment

Finc.Dev: Financial Development

GDP: Gross Domestic Product

GEMS: Global Environmental Monitoring System

JD: Jordanian Dinar

KPSS: Kwiatkowski-Phillips-Schmidt Shin

MENA: Middle East and North Africa

OECD: Organization for Economic Cooperation and Development

ORNL: OakRidge National Laboratory

R&D: Research and Development

SBC: Schwarz Bayesian Criterion

VAR: Vector Auto Regression

VECM: Vector Error Correction Model

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Chapter 1: Introduction

1.1 Preface

Since the eighties of the last century, maintenance and protection of the environment became a top economic and social priority across the globe. This vision has been adopted by many international organizations including the United Nations, which established a specialized body called the "United Nations Environment Programme". The first Conference on Environment was held in Stockholm in 1972 as an attempt to study and address the relationship between the environment and development at the global level. After that, many seminars and conferences were held, and the most important conference called “The Earth Summit’ was held in Rio de Janeiro in 1992. Another conference, which aimed to discuss sustainable development, was held in Johannesburg in 2002 (Alwan and Tarawneh, 2014).

Economists gave great attention to the relationship between the environment and economic activity. In economics, the environment is defined as the base that holds all economic activities and the base of the sustainability of life. However, this sustainability can be only achieved by the provision of safe environmental systems. (Alwan and Tarawneh, 2014)

Emissions of carbon dioxide have recently been considered a major problem internationally, as a result of the negative effect of these emissions on climate changes. Climate changes include changing rainfall patterns, an increase the intensity of storms, a reversal in oceans currents, and rising sea levels. These changes have significant impacts on ecosystems, and the survival of wildlife and well-being of human kind (Boutabba, 2013).

1.2 Problem Statement

Due to the importance of carbon emissions' issue, this study aims to analyze the effects of financial development, GDP, energy consumption, trade openness on carbon emissions. This will be done by answering the following questions:

1. How has the financial development in Jordan changed over the period (1980-2011)?

2. How has the carbon emissions in Jordan changed over the period (1980-2011)?

3. What is the impact of GDP on carbon emissions?

4. What is the impact of square of GDP on carbon emissions?

5. Is environmental Kuznets curve achieved in Jordan?

6. What is the impact of financial development on carbon emissions?

7. What is the impact of trade openness on carbon emissions?

8. What is the impact of energy consumption on carbon emissions?

1.3 Objectives of the Study

The main objective of the study is to analyze the impact of financial development and other variables on carbon emissions. Moreover, the specific goals to be achieved are:

1. Observing the change in financial development in Jordan over the period (1980-2011).

2. Identifying how of GDP, energy consumption, trade openness on carbon emissions change over time.

3. Estimating the impact of GDP, financial development, energy consumption and trade openness on carbon emission.

4. Suggesting some recommendations that help decision-makers in order to facilitate the reduction of carbon dioxide emissions.

1.4 Importance of the Study

Carbon dioxide is a toxic gas; its presence in large quantities in the atmosphere negatively affects the environment. Consequently, humans, animals, plants, and all forms of life would be adversely affected.

To the best of our knowledge, there has never been an attempt to investigate the determinants of carbon emissions in Jordan, by taking into account the financial development, using single country data and using the Autoregressive Distributed Lag

Model (ARDL). This study tries to fulfil this gap. Also, currently, literature offers few studies which address the effect of CO_2 on the environment as a whole. It is, therefore, necessary to conduct a study to identify the factors which affect CO_2 emissions and their effect on the gas's levels in the atmosphere.

Identifying factors affecting CO_2 emissions will help decision-makers in formulating the needed policies. On the one hand, policy makers should aim to reduce carbon dioxide emissions. However, this should be done while attempting to maintain sustainable development and economic growth levels as much as possible.

1.5 Methodology of the Study

In order to achieve the previous objectives, the study uses econometric analysis to examine the long run equilibrium, the existence and the direction of a causal relationship between carbon emission, financial development, economic growth, energy consumption and trade openness in Jordan. In particularly, the study uses the Autoregressive Distributed Lag (ARDL) bounds testing procedure, unit root test and Granger Causality test to analyze such relationships.

The study uses time-series data for the period (1980-2011), obtained from the World Bank and UNCTAD databases.

1.6 The Limitations of the study

This study will be conducted on the Jordanian economy. Annual data are obtained from the World Bank covering the period from 1980 - 2012. Energy consumption data were limited and starting from the year 1980, so it was determined the study period due to lack of data on energy consumption offer before this date. Collected data was processed and analyzed using E-Views.

1.7 Contents of the Study

This study is organized as follows: Chapter 2 presents the theoretical framework; which contains a full description of theories used. Chapter 3 reviews the literature on some countries that study CO_2 emissions. Chapter 4 describes the Jordanian economy. Chapter 5 contains a full description of methodology used, empirical review about ADF test, and description of Autoregressive Distributed lag model. Analysis and results are discussed in chapter 6. Chapter 7 concludes and gives policy recommendations.

Chapter 2: Theoretical Framework

The objective of this study is to examine the impacts of financial development, GDP, energy consumption, trade openness and carbon emissions in Jordan. Following the empirical literature, according to Kuznets (1955) expected that the altering relationship between per capita income and income inequality is a reversed -U-shaped curve. As per capita income rises, income inequality also rises initially but starts decreasing after a turning point. In other words, the distribution of income is more unequal at initial stages of income growth and then the distribution transfers towards greater equality as economic development continues. This observed empirical phenomenon is commonly well-known as the Kuznets Curve.

The origin of the Environmental Kuznets Curve (EKC) is the growth controversy and related strategies. Researchers postulate that a higher amount of income raises environmental degradation. Essentially, greater levels of income may decrease environmental degradation (Beckerman, 1992). Therefore, economic growth might be a condition for environmental enhancement (Bhagawati, 1993). Hence, growth could be an active way for improving environmental quality in developing countries (Panayotou, 1993). The argument according to which economic growth is beneficial for environment is debated since it stimulates the thought of an improvement path, a stage based link between environmental quality and economic growth.

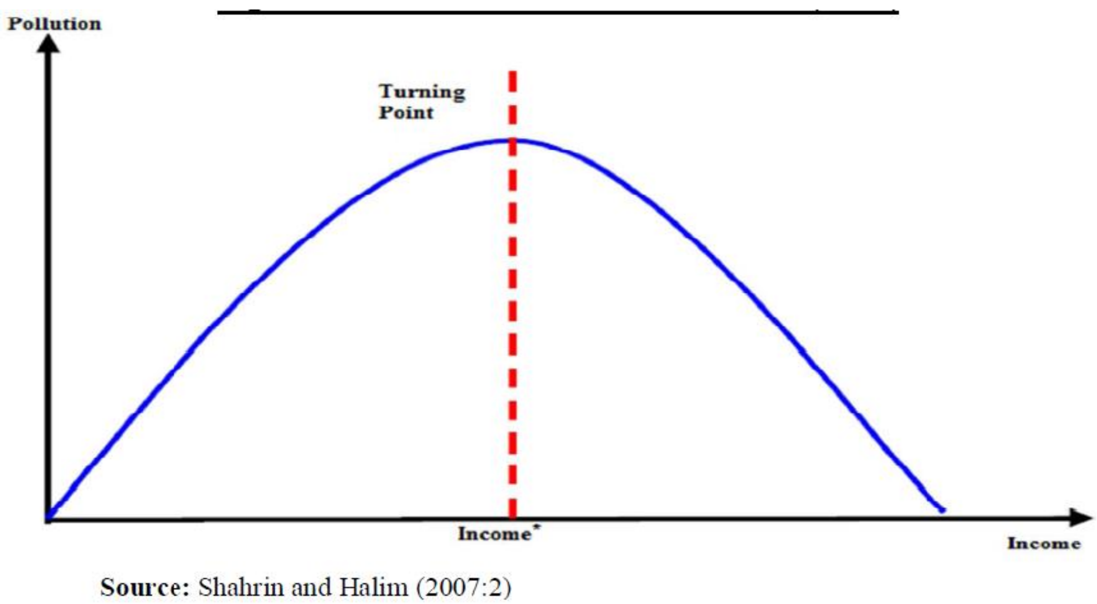
Since 1990, data on different pollutants has been available over the Global Environmental Monitoring System (GEMS), the environmental information collection of the OECD, the CO_2 emissions assessments from the Oak Ridge National Laboratory (ORNL), etc. These data availability induce several authors to examination the validity of the inverted-U shaped hypothesis for income and environmental quality indicators. The initial practical study seems by Grossman and Krueger (1991); later, a number of studies follow.

The inverted-U derived by Grossman and Krueger (1991) in 1991 about the relationship between economic development and environmental quality was named the Environmental Kuznets Curve (EKC) by Panayotou (1993) and has been continued from (Chen, 2007). According to EKC, when economic growth reaches a certain level, it will discuss the environmental impacts of the first stages of economic growth and compensate for it (Sun, 1999).

According to EKC hypothesis, the relationship among per capita GDP and per capita pollutant emissions looks like an inverted-U. It means that economic development may co-exist with better environmental quality after a certain point (Niu and Li, 2014).

The EKC hypothesis suggests that rise in pollution will initially be due to development of country’s industry and then it will be reduced after a certain economic growth level is reached. Thus, environmental deterioration is expected at the initial stages of economic growth and for this reason countries are obliged to bear it until the reversing effect. This situation is seen in Figure 1 (Shahrin and Halim, 2007).

Figure 1: The Environmental Kuznets Curve (EKC)



Source: Shahrin, A., Halim, A. (2007). Introduction to Environmental Kuznets Curve (EKC).

Energy production and consumption generate an important portion in the improvement pattern of CO_2 emissions. In this sense, it acts as an engine of industrial enhancement and economic growth. Thus, a country with substantial consumption of energy is supposed to also have a great life standard. Though, high energy consumption causes great carbon emissions which have an opposite effect on the environment (Alkhathlan and Javid, 2013). Continually increasing CO_2 levels and its inhibition on the greenhouse influence displays the importance of this problem. Academicians and policy-makers have an agreement on the necessity of decreasing the emissions of greenhouse gas to lessen global warming (Zhang and Cheng, 2009). Many studies like Boutabba (2013), Soytas*et al*. (2007), Jalil and Feridun (2011), Shahbaz*et al*. (2011) and other state that the relationship between energy use and CO_2 emissions is expected to be positive, because a higher level of energy consumption should result in greater economic activity and stimulates CO_2 emissions.

In this study, the financial development defined as the total value of domestic credit to private sector as a share of GDP. The importance of total value of domestic credit to private sector arises from attract FDI and greater degrees of R&D investments which in turn can speed up economic development (Frankel and Romer, 1999), and therefore affects the dynamic of environmental performance. The total value of domestic credit to private sector offers developing countries with different technology; aid them with clean and environment-friendly production, which improve local development sustainability (Birdsall and Wheeler, 1993; Frankel and Rose, 2002). The third reason, differing to the previous one, is that though the total value of domestic credit to private sector may improve economic growth, it may result in more industrial pollution and environmental degradation (Jensen, 1996).

Accordingly, the expected relationship between the financial development and CO_2 emissions may be either positive or negative; since if we consider that Financial development may be hurtful for environmental quality then the coefficient of it is positive, but if the emphasis of financial sector is to improve environmental quality by enabling companies in adopting innovative cleaner and environment friendly techniques then the coefficient of it is negative.

The relationship between the trade openness and the CO_2 emissions may be negative or positive, depending on the level of economic growth stage of a country. In the situation of developed countries, it is expected to be negative as countries grow; they stop to bring certain pollution intensive goods and begin to import these from different countries with less-restrictive environmental protection laws. This sign expectation is reversed in the situation of developing countries as they have a tendency to have unclean industries with a substantial share of toxins, (Grossman and Krueger 1995).

Chapter 3: Literature Review

CO_2 emissions have been considered by many researchers. Most of these studies have attempted to identify the factors which influence CO_2 emissions and their level, as well as the direction of their influence. The most prominent variables which were found to influence carbon emissions were financial development, economic growth, trade openness, and energy consumption. Below, the study provides a review of literature on these variables.

Many of the studies used the Autoregressive Distributed Lag (ARDL) testing procedures (Boutabba, 2013; Ozturk and Acaravci, 2013; Jalil and Feridun, 2011; Shahbaz *et al*., 2011; Zhang, 2011; Tamazian *et al*., 2009; Sadorsky, 2010). Additionally, some studies used the co-integration theory, vector error-correction modeling techniques, Granger causality test, and variance decomposition (Zhang, 2011; Menyah and Wolde-Rufael, 2010; Soytas and Sari, 2009; Ang, 2007).

3.1 Financial Development and CO_2 emissions

Among the variables examined, financial development was by far the most popular. Using the Autoregressive Distributed Lag (ARDL) testing procedures, as well as, the ARDL bound testing procedure and employed co-integration theory, vector error-correction modeling techniques, Granger causality test, Ozturk and Acaravci (2013) examine the relationship between carbon emission, financial development, economic growth, energy consumption and trade openness in Turkey from 1960 to 2007. Using the Autoregressive Distributed Lag (ARDL) bound testing procedure. They use the domestic credit to private sector as indicator of financial development. Conducted a study in Turkey which indicated that financial development has no significant effect on CO_2 emissions. However, many other showed that financial development indeed has a significant relationship with CO_2 emissions.

According to Sadorsky (2010) and Zhang (2011), they measured the impact of financial development on carbon emissions by co-integration theory, Granger causality test, variance decomposition, financial development leads to an increase in CO_2 emissions through the following: Firstly, stock market development helps listed enterprises to lower financing costs, increase financing channels, disperse operating risk and optimize asset/liability structure, so as to buy new installations and invest in new projects and then increase energy consumption and carbon emissions. Secondly, financial development may attract foreign direct investment so as to boost economic growth and increase carbon emissions. Thirdly, prosperous and efficient financial intermediation seems conducive to consumers' loan activities, which makes it easier for consumers to buy big ticket items like automobiles, houses, refrigerators, air conditioners, washing machines, etc. and then emit more carbon dioxide. Unidirectional causality running from financial development to economic growth is identified (Omri *et al*. (2015)).

Many studies support these claims. Boutabba (2013) examines the long run equilibrium, the existence and the direction of a causal relationship between carbon emission, financial development, economic growth, energy consumption and trade openness in India. The study use the Autoregressive Distributed Lag (ARDL) testing procedure and Zhang (2011), whose studies were conducted in India and China respectively, both, indicated that financial development has a positive and significant effect on CO_2 emissions. More specifically, Zhang (2011) studied the effect of various proxies of financial development on carbon emissions. The study indicated that the influence of financial intermediation scale on carbon emissions outweighs that of other financial development indicators but its efficiency's influence appears by far weaker although it may cause the change of carbon emissions statistically. Additionally, the study indicates that China's stock market scale has relatively larger influence on carbon emissions but the influence of its efficiency is very limited. This, to some extent, reflects the relatively lower liquidity in China's stock markets. Finally, even though China's FDI seems to exert the least influence on the change of carbon emissions, due to its relatively small volume, the researcher suggests that these foreign investments could play a positive role in the future if they are directed towards low carbon sectors and away from carbon intensive sectors.

On the other hand, several other studies found opposite results. Jalil and Feridun (2011) study the impact of growth, energy and financial development on the environment in China for period from 1953 to 2006 using the (ARDL) bound testing procedure, for example, used two proxies for financial development, first the ratio of deposit liabilities to nominal GDP, second, the ratio of commercial bank assets to the sum of commercial bank and central bank assets. The results show that financial development has a negative and significant influence on environmental pollution. Similarly, Tamazian *et al*. (2009), conducted in BRIC countries, indicated that higher degrees of economic and financial development positively affect the environment and reduce pollutant levels. Shahbaz *et al*. (2011), in Pakistan, provides similar results.

Given such results, studies such as Tamazian *et al.* (2009) investigate the linkage between economic development, environmental quality and financial development. They suggest that financial liberalization and openness are essential in order to reduce CO_2 levels. Moreover, Shahbaz *et al.* (2011) use the Autoregressive Distributed Lag ARDL bounds testing approach to co-integration is implemented to the data for 1974-2009 to explores the existence of a long run equilibrium relationship among CO_2 emissions, financial development, economic growth, energy consumption, and population growth in Pakistan. The study suggested that policy makers should establish a policy to support financial development, since such a policy is necessary to attract FDI and to encourage transfer of technology as well as to enhance production, while also allowing the economy to become less carbon dependent.

3.2 Domestic Product, Economic Growth, and Domestic Income and CO_2 emissions

Another variable which attracted researchers' attention is domestic product and economic growth. Using the Autoregressive Distributed Lag (ARDL) testing procedures, the co-integration theory, vector error-correction modeling techniques, Granger causality test, Shahbaz *et al*. (2011) finds that economic growth is a main contributor to CO_2 emissions. Similarly, Boutabba (2013) find that per capita GDP levels have a positive and significant long run effect on per capital CO_2 levels. In South Africa, Menyah and Wolde-Rufael (2010) provides supporting results. Their study points to the existence of a short-run as well as a long-run relationship among the variables with a positive and a statistically significant relationship between pollutant emissions and economic growth. Also (Soytas *et al*, 2007) found that there is no differentiation between emission reduction and income growth in the US.

Furthermore, Menyah and Wolde-Rufael (2010), study the long-run and the causal relationship between economic growth, pollutant emissions and energy consumption for South Africa for the period 1965–2006 in a multivariate framework which includes labor and capital as additional variables. Using the bound test approach to co-integration. By applying a modified version of the Granger causality test which indicated that a unidirectional causality exists, running from pollutant emissions to economic growth; from energy consumption to economic growth and from energy consumption to CO_2 emissions all without a feedback. The econometric evidence suggests that South Africa has to sacrifice economic growth or reduce its energy consumption per unit of output or both in order to reduce pollutant emissions. In the long-run however, it is possible to meet the energy needs of the country and at the same time reduce CO_2 emissions by developing energy alternatives to coal, the main source of CO_2 emission.

Alternatively, Omri *et al.* (2015), examines the relationship between financial development, CO_2 emissions, trade and economic growth using simultaneous-equation panel data models for a panel of 12 MENA countries over the period 1990-2011, find evidence which supports the existence of bidirectional causality between CO_2 emissions and economic growth.

Moreover, the literature concentrated on the relationship between CO2 emissions and income levels which is used as a measure of economic growth. This relationship, which has become known as Environmental Kuznets Curve (EKC) places carbon emissions as the dependent variable with income and square of income as independent variable. The EKC hypothesis indicates that this relationship is quadratic; environmental quality deteriorates at the early stages of economic development and then improves at later stages. In other words, pressure on the environment increases faster than income at early stages of development, but slows down relative to GDP later stages (Dinda 2004).

Jalil and Feridun (2011) support the EKC hypothesis in China. Income has a positive and significant influence on carbon emissions.

While, the square of income has a negative and significant influence on environmental pollution. Similarly, Omri *et al.* (2015), Shahbaz *et al*. (2011), Soytas *et al*. (2007), and Ang (2007) support the existence of an EKC-type relationship in Pakistan, US, and France respectively. Moreover, Ang (2007) examines the dynamic causal relationships between pollutant emissions, energy consumption, and output for France by co-integration and vector error-correction modeling techniques. He performs two causality tests to throw light on the causal links of output of energy and pollution. The results show that output growth causes CO_2 emissions and energy consumption in the long run. A unidirectional causality running from growth of energy use to output growth is observed in the short run. The lack of a long run causal relationship between income and emissions may be mean that to reduce carbon emission, Turkey does not have to forgo economic growth (Soytas and Sari 2009).

3.3 Trade Openness and CO_2 emissions

Additionally, many studies have found a link between CO_2 emissions and trade openness [Boutabba, 2013; Ozturk and Acaravci, 2013; Jalil and Feridun, 2011] with contradicting results. In India, Boutabba (2013) indicated that trade openness negatively influences CO_2 levels, whereas in Turkey; Ozturk and Acaravci (2013) found that there’s a positive and significant relationship between CO_2 and trade openness. Unidirectional causality running from trade openness to CO_2 emissions is identified Omri *et al*. (2015).

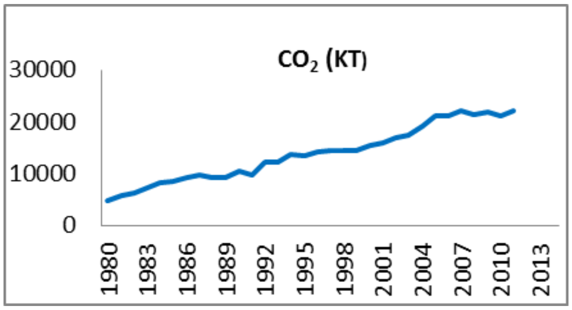
3.4 Energy Consumption and CO_2 emissions

Finally, researchers have attempted to address the link between CO_2 emissions and energy consumption. Unsurprisingly, most studies agree that energy consumption is a main driver of CO_2 levels in the environment [Boutabba, 2013; Ozturk and Acaravci , 2013; Jalil and Feridun, 2011; Shahbaz *et al*., 2011; Soytas *et al*., 2007; Ang, 2007]. Soytas and sari (2009) show that carbon emissions Granger cause energy consumption but the reverse is not true.

Chapter 4: An Overview of the Jordanian Economy

By comparing the carbon emissions in Jordan with neighboring countries, we find that the carbon emissions in Jordan reached 3.6 metric tons per capita and this is a large amount compared with Tunisia, which amounted to 2.4 metric tons per capita. For Egypt carbon emissions reached 2.6 metric tons per capita which is less than that of Jordan. Also, carbon emissions in Morocco amounted to 1.7 metric tons per capita which is a very small amount compared with Jordan.

Figure 2: Time Series Plots of the CO_2 Emissions.

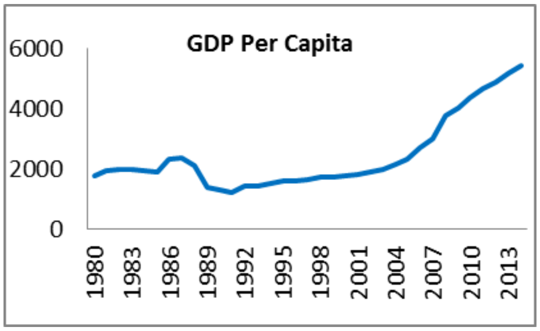


It is evident from Figure.2 that the levels of carbon emission have significantly increased over time.

4.1 Gross Domestic Product

The Jordanian economy had witnessed remarkable developments during the past four decades, where the GDP has grown more than the natural growth of any non-oil developing country. According to the World Bank reports, Jordanian GDP has risen from about 22 million USD in 2008 to about 29 million USD in 2011.

Figure 3: Time Series Plots of the GDP.



The graph in figure 2 shows how the GDP changes with time in Jordan. The figure above demonstrates/shows the levels of per capita GDP over time. We observe that for GDP per capita during the period of 1980-2011 GDP increased, except for the period between 1988 and 1991 where GDP level declined as a result of the economic crisis that negatively affected the Jordanian economy. It is important to note that the economic crisis was mainly caused by the deterioration of exchange rate during that period (Radaideh, 2009).

Moreover, Jordan has achieved success in structural reforms in education, health, privatization and liberalization. In 2015, Jordan has focused on identifying concrete steps towards enhancing the investment climate and easy of doing business. Jordanian Real GDP Growth increased from 2.3% in 2010 to 2.6% in 2011. Real GDP growth is expected to attain 3.7% in 2016, reflecting investment projects in the medium term (World Bank, 2014).

The Jordanian economy is considered a service economy. In 2013, the service sector constituted 67%, while the agricultural sector constituted the least share of GDP, which is 3.2%. As for the industrial sector, it constituted only 29.9% of the GDP (Central Bank of Jordan, World Bank)

Nonetheless, Jordan faces overwhelming difficulties due to the regional shakiness, high unemployment, a reliance on grants and remittances from bay economies and proceeded pressure on natural resources. The internal net public debt has increased by 663 million JD by the end of 2014 compared to 2013 (49.2% of the GDP), whereas the external public debt has increased by 795.6 million JD to reach 8,030.1 million JD (31.6% of the GDP) (World Bank).

Hence, it will be indispensable for Jordan to continue diversifying its energy supply in the medium term so as to decrease the large twin deficits and macroeconomic vulnerabilities. Moreover, sound economic policies and development improving changes will likewise be important to diminish the country's vulnerability to external shocks.

4.2 Banking Sector

Jordan's banking sector is one of the main pillars supporting the economy. While the sector is described as saturated, it was only marginally able to withstand during the financial crisis and economic slowdown, and in spite of all this, the banking sector in Jordan can be described as advanced and modern, and thus it became a preferred investment destination. The conservative policy that was used by the Jordanian central bank has helped Jordan to avoid the global financial crisis in 2009, as the

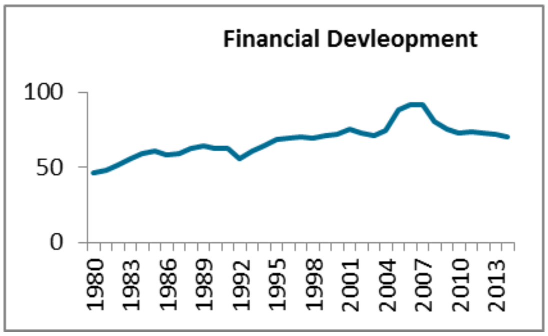
Jordanian economy grew at a rate of 10% in the period between 2002 and 2007. Jordanian government has signed loans and aid agreements under which it gets aid and loans for the government and private sectors. The amount of loans that Jordan can get was not specified in those agreements, so Jordan was able to obtain loans up to165.6 million dollars in 2015. These loans were distributed to support small and medium-sized private projects and establishments and for small and medium-sized private sector that totaled $ 108 million, and loans for the implementation of the seventh stage of the *Samra* power plant that totaled $ 57.6 million (Central Bank of Jordan). .

Making conditions for expanded private investment and enhanced competitiveness will help attain/ achieve the growth needed to generate employment and decrease poverty. So the CBJ introduced a considerable set of measures to synchronize banks operations, improve their ability to finance economic activities, and to strengthen the soundness of the banking sector. In addition, the CBJ dedicated special attention to promote financing of Small and Medium sized Enterprises (SMEs).

4.3 Credit Facilities

The Central Bank of Jordan has extended the credit facilities to reach JD 19.3 billion in 2014, with an increase of JD 334.8 million (1.8%), compared to an increase by JD 1,109.9 million (6.2%) in 2013. The distribution of credit facilities, according to economic activity, revealed that credit facilities for "construction" activities increased by JD 466.4 million (11.4%); "other credit facilities" (mostly representing facilities extended to individuals for consumption purposes) also witnessed an increase by JD 348.4 million (8.4%). On the other hand, credit facilities extended to the general trade and transportation services declined by JD 253.5 million (6.4%), and JD 244 million (5.95%), respectively (Central Bank of Jordan, 2014).

Figure 4: Time Series Plots of the Financial Development.



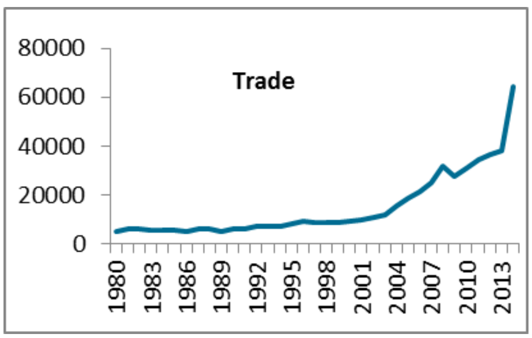
The graph in figure 2 shows the financial development changes with time in Jordan. Financial development has fluctuated from year to year, but had an increasing trend until the beginning of the year 2007. After that the financial development started to decline.

The distribution of credit facilities, according to economic activity, revealed credit facilities for "construction" activities approximately 23.46 percent; "other credit facilities" (mostly representing facilities extended to individuals for consumption purposes) also witnessed approximately 41.83 percent. On the other hand, credit facilities extended to the general trade and industry and mining approximately equal 19.89 percent, and 14.79 percent, respectively (Central Bank of Jordan, 2014).

4.4 International Trade

Regarding the external trade sector, the total was (5953.6) million JD in 2014, with an increase of 6% compared to the same period of 2013. The national exports totaled 5163.7 million JD in 2014, with an increase of 7.5% compared to the same period of 2013. As for imports, it amounted to 16145.9 million JD during 2014, with an increase of 3.1% compared to the same period of 2013(The Ministry of Industry and Trade and Supply, 2014).

Figure 5: Time Series Plots of the Trade Openness.



The graph in figure 2 shows how trade openness changed with time in Jordan. For time series plots of variable trade openness its evident from the graph above that the trade openness has an overall increasing trend and it is clear that there was a sharp increase in trade in 2013 and 2014.

Regarding the composition of the main exported and imported commodities, the value of exports of clothing has increased by 12.1%, and fruits and vegetables by 24.7%, while the value of pharmaceutical supplies has decreased by 3.2%. On the other hand, the imported commodities recorded an increase in the crude by 9.2, whereas electrical machinery, apparatus and their parts increased by 29.5% (The Ministry of Industry and Trade and Supply, 2014).

4.5 Energy and Debt Sectors

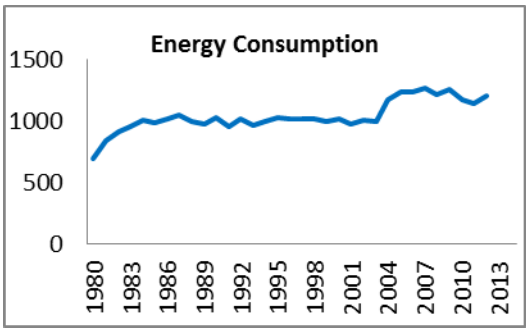
The effect of the huge financial flows that was available for the Jordanian government, including loans that were turned into public debt and affected on economic development, was very limited. This limited effect is due the fact that the majority of investments were made in service activities, not production activities. The service sector constituted 65% limited regrettably, the reason for this is that most of the investments were in services, not production, where the services sector remained constitutes about 65% of the economy, and government services constitutes the majority of this sector.

As the government employs about half of the Jordanian labor force; the growth of the service sector should have encouraged/ stimulated the development of the productive base of the national economy, by taking advantage of the huge financial flows that could preserve the growth of the economy. If the financial flows were used in the development of the production base, this would have solved the issues of poverty and unemployment, by establishing production complexes, and using the abundant resources such as potash, phosphates and oil shale. However, those flows were drained to fund unnecessary projects for a poor country, and plunged the country in indebtedness. The debt service and current expenditures constituted most of the revenues and financial flows, and increased reliance of the country on the foreign countries to provide the basic needs and consumption commodities. Hence, deepened the economic crisis. Chronic deficits and trade deficits were the most prominent characteristics of the economic crisis, and successive governments have carried the burden of these crises to the people through the increased indirect taxes, especially sales tax. " However, the use of the financial flows in sectors that do not depend on polluting production techniques, especially in the industrial sector, has benefited Jordan in achieving a good environment with low pollution caused by CO_2 emission.

Since energy is considered the prerequisite for the economic development in any country; energy resources are the basic input for most of economic activities and the main engine for the different economic sectors as well. However, the energy sources are very limited in Jordan, as the percentage of energy production is very low. Jordan's production of crude and natural gas during the period between 2007-2011 was 3.2% of the total energy. So, under the situation of the limited production of energy, Jordan basically relies on importing the energy resources like crude oil, oil derivatives and gas to meet the needs of the national economy. The use of energy resources in Jordan has taken an upward trend, as the annual growth rate of its use reached 4.6% during the period 2010-1980 (Alwan and Tarawneh, 2014).

This situation reflects the growing demand for energy resources by the different economic sectors, and the importance of those resources to meet the requirements of the economic sectors and the process of economic development.

Figure 6: Time Series Plots of the Energy Consumption.

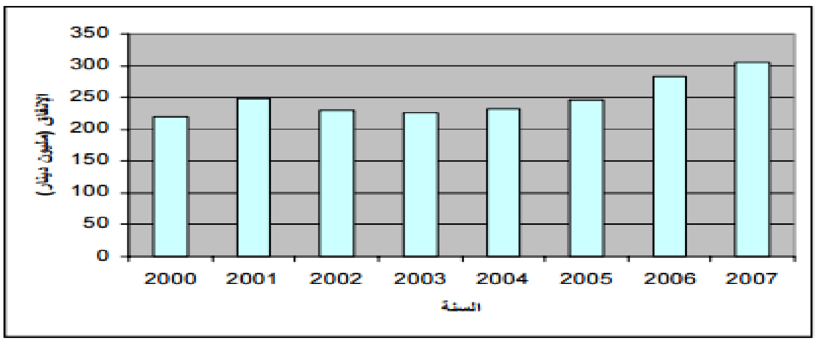


The graph in figure 2 shows how energy consumption changes with time in Jordan. The energy consumption has witnessed steady increases several until 2004 its increases more than the last years.

4.6 Environmental Issues and IT Sector

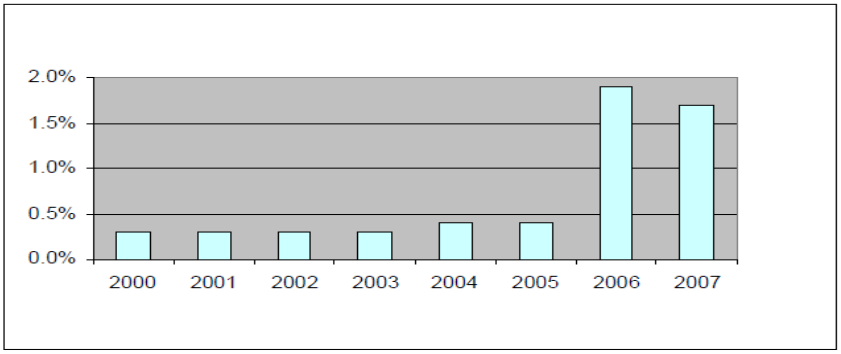
In a study about the public spending on environment in Jordan for the year 2009, the environmental expenditure of the public sector by the economic dimension was calculated, where the economic dimension was defined in the study as the total expenditures, capital and current. The following figure shows the increase in the total public expenditures on the environment during the period (2000-2007) from 219.9 million JD in 2000 to 306.1 million JD in 2007. This increase reflects the commitment of the Jordanian government to provide environmental protection services, and shows increased attention of the government to the environmental issues.

Figure 7: Public Expenditures on the Environment (m) During the Period (2000-2007)



The increase in expenditures of the ministry of environment in the last two years compared with environmental expenditures during the period (2000-2005), as shown in figure 5, clearly demonstrates the government's growing interest in environmental issues.

Figure 8: Environmental Expenditure Ratio of the Ministry of Environment of the Total Environmental Expenditure (2000-2007)



Sources: Public Environmental Expenditures Case Study: Jordan, 2009.

Recently, Jordan has taken several measures to reduce CO_2 emissions. Firstly, policy makers encouraged investments in small and medium size enterprises which create low-level carbon emissions. Secondly, the country has made attempts to replace fossil fuel with alternatives that produce less carbon, natural gas for example. Thirdly, Jordan has invested around JD 20 million in a project which intended to provide a grading system for factories based on their CO_2 emissions. Fourthly, this project provided funding for these factories in order to replace their machinery with low-carbon emitting ones. Fifthly, another initiative by the government attempted to establish a 'mobile environment and energy clinic' whose objective is to measure factories' CO_2 emissions in order to help them cut these costs.

Additionally, this clinic aims at helping enterprises in adopting measures to protect the environment and reduce water consumption (Radaideh, 2009). Finally, in order to control CO_2 emissions in the transport sector, the government aims to establish light train systems and has enacted policies to reduce sales taxes, customs, and any other fees for vehicles with small engines (Al-Saoub, 2011).

Information Technology (IT) is often mentioned as one of Jordan's most encouraging and fastest growing- sectors. Last year, it rose by 25% and accounted for 14% of the country's GDP according to the ICT Association of Jordan. Jordan has taken steps to launch major IT actions aiming at developing the sector as it is considered an area in which Jordan can raise its competitive benefit over other countries in the region (Curley, 2013).

IT sector is attractive policy and regulatory environment, and it includes many of key policy objectives: Firstly, creating a competitive environment, led by the private sector that contributes to the economic & social development. Secondly, market liberalization to encourage and attract investment, contributing to offering a wider variety of services. Thirdly, raising internet penetration rates IT sector, elements of communication, is not typically regulated. Fourthly, Intellectual Property laws are in effect and considered to be the model in terms of structure and compliance across the developing world (Economic & Commerce BUREAU).

Chapter 5: Methodology and Data

The objective of this article is to analyze the effects of financial development, GDP, energy consumption, trade openness and carbon emissions in Jordan. Following the empirical literature [Boutabba, 2013; Ozturk and Acaravci , 2013; Jalil and Feridun, 2011; Shahbaz *et al*., 2011; Soytas *et al*., 2007; Ang, 2007], the relationship between dependent and independent variables can be expressed as the following:

$CO_2 = \beta_0 + \beta_1 Y + \beta_2 Y^2 + \beta_3 E + \beta_4 F + \beta_5 T + \varepsilon_t$ ……………………………(1)

Where CO_2 is carbon emission (measured in Kilo tone), Y indicates per capita GDP (measured in local constant currency), Y^2 is the square of per capita GDP, E is the energy consumption (measured as kg of oil equivalent), F is the financial development that is the total value of domestic credit to private sector as a share of GDP, and T represents trade openness, which is the total value of exports and imports as a share of GDP. All of these variables were obtained from the World Bank, while, trade openness, which takes from the UNCTAD data base.

The parameters β_1, β_2, β_3, β_4, and β_5 are the long-term elasticity of CO_2 emissions with respect to per capita GDP, the squared per capita GDP, energy use, financial development and trade openness respectively. The sign of β_1 is expected to be positive. Under the EKC hypothesis, a negative sign is expected for β_2. The statistical insignificance of β_2 recommends a monotonic increment in the relationship between pollutant emissions and per capita GDP. This can also be explained as follows: $\beta_1$being positive uncovers the phenomenon where the CO_2 emissions increase income increases as well. β_2 being negative reflects the inverted-U shaped pattern of the EKC, where once income passes the threshold, the CO_2 emissions will decrease.

The coefficient of energy use $\beta_3$expected to be positive, because a higher level of energy consumption should result in greater economic activity and stimulates CO_2 emissions [Boutabba (2013), Soytas*et al*. (2007), Jalil and Feridun (2011), Shahbaz*et al*. (2011) and other].

β_4 indicates the financial development; the expected sign may be either positive or negative. If we consider that Financial development may be harmful for environmental quality then $\beta_4 > 0$ [Boutabba (2013), Sadorsky (2010), Zhang (2011)], but if the aim of the financial sector is to enhance environmental quality by empowering firms in adopting advanced cleaner and environment friendly techniques then $\beta_4 < 0$ [Jalil and Feridun (2011), Omari *et al.* (2015), Shahbaz *et al*. (2011), Tamazian *et al*. (2009)]. The sign of trade openness expected to be negative or positive, depending on the country's level of economic development. In the case of developed countries, it is expected to be negative as countries develop; they stop to deliver certain pollution intensive goods and start to import these good from different countries with less-restrictive environmental protection laws[Boutabba (2013), Ozturk and Acaravci(2013), Jalil and Feridun(2011), Omri *et al*. (2015)]. This sign expectation is reverse in the case of developing countries as they tend to have dirty industries with a heavy share of pollutants, (Grossman and Krueger 1995).

It is important to note that the data is obtained both from the World Bank and the UNCTAD databases and it covers the period from 1980 to 2011.The sample covers the period from 1980 to 2011. The data is obtained both from World Bank and UNCTAD databases.

5.1 Estimation Strategy

The Autoregressive Distributed Lag (ARDL) bounds testing procedure introduced by Pesaran et al. (2001) and Pesaran and shin (1999) used to test the long run equilibrium relationship between CO_2 emissions and the explanatory variables (financial development, GDP, energy consumption, and trade openness).

The ARDL has become popular amongst researchers compared to other single co-integration procedures. The advantages of applying ARDL are: Firstly, even where a portion of the model regressors are endogenous, the bounds testing approach for the most part gives unbiased long-run estimates and valid t-statistics (Narayan, 2005), so endogeneity problems on the estimated coefficients over the long-run associated with the Engle-Granger method are avoided. Secondly, the short-run and long-run parameters of the model being referred to are evaluated in the same time. Thirdly, it can be applied regardless of whether the fundamental variables are I (0), I (1) or a combination of both (Pesaran and Pesaran, 1997). Fourthly, the ARDL procedure is a statistically more significant approach in determining the co-integration relation in small samples to those of the Johensen and Juselius co-integration procedure (Pesaran and Shin, 1999). Fifthly, the model takes an adequate number of lags to catch the data generating process in a general to specific modeling frameworks (Laurenceson and Chai, 2003). Sixthly, the error correction model (ECM) can be derived from ARDL through a simple linear transformation, which integrates short run modification with long run equilibrium without losing long run data (Pesaran and Shin, 1999).

Basically, the ARDL approach to co-integration includes two stages for assessing long-run relationship. The first step is to explore the presence of long-run relationship among all variables. If there is an evidence of co-integration between variables, the second step is to estimate the long-run and short-run models.

5.2 An Overview of Unit-root Test

Many economic time series data exhibit to have trending behavior. An important econometric task is determining the most appropriate form of the trend in the data. If the data are trending, then some form of trend removal is required, so the unit root test is applied. Unit root tests are used to verify the stationarity of a series and its can be used to determine if data is stationary or not (have unit-root).

How do we test for a unit root?

The early work on testing for a unit root in time series was done by (Dickey and Fuller 1979, Fuller 1976). The basic objective of the test is to examine hypothesis that $\varphi=1$ using:

$Y_t=\varphi Y_{t-1}+u_t$

H_0: series contains a unit root

H_1: series is stationary.

Where the null hypothesis says that the series contain a unit root (the variables non-stationary), while the alternative hypothesis states that the variables are stationary.

There is a different form for the Dickey Fuller tests regressions used to show the existence of unit-root test: without intercept and trend, with intercept only and with both intercept and trend as shown in the following forms:

The first: without trend and intercept

$\Delta Y_t = \varphi Y_{t-1} + u_t$

The second: with intercept only

$\Delta Y_t = \beta_0 + \varphi Y_{t-1} + u_t$

The third: with both intercept and trend

$\Delta Y_t = \beta_0 + \beta_1 t + \varphi Y_{t-1} + u_t$

According to Ouattara (2004), the computed F-statistics provided by Pesaran et al. (2001) becomes invalid in the presence of I (2) (series integrated at order 2) variables. This is because the bounds test is based on the assumption that the variables should be I (0) or I (1) which means series integrated at order 0 and 1 respectively. So, the enforcement of unit root tests in the ARDL procedure is necessary to test that none of the variables is integrated at an order of I (2) or beyond. When variables are non-stationary at level then we apply the first difference operator. For example, if a non-stationary series differenced d times before it becomes stationary, then it is said to be I (d). In addition, if we apply the unit root test at level and the series is a stationary we denote it as I (0).

In order to study the existence of stationary series, we can employ the Augmented Dickey–Fuller (ADF), Phillips–Perron, ADF-GLS, and KPSS unit-root techniques. However, The KPSS method tests the hypothesis that there is no unit root (the series is stationary) against the alternative of a unit root (non-stationary). In addition, Phillips and Perron have developed a more inclusive theory of non-stationary unit root. The tests are similar to ADF tests, but they insert an automatic correction to the DF procedure, and the test usually gives the same conclusions as the ADF tests, but the computations of the test statistics are relatively complicated.

5.3 Autoregressive Distributed Lag (ARDL) Co-integration Analysis

A recent single co-integration method, known as autoregressive-distributed lag (ARDL) bounds testing approach of co-integration is introduced by Pesaran and Shin (1999) and Pesaran et al. (2001). The ARDL co-integration approach has numerous advantages in comparison with other co-integration methods such as Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990) procedures. Basically, for estimating long-run relationship, the ARDL bounds testing approach of co-integration involving two steps: The first step is to examine the existence of long run relationship among all variables in the equation. In particular, The ARDL model can be expressed as the following:

$$\Delta CO_2 = \beta_0 + \sum_{i=1}^{p} a_{1i}\Delta CO_{2t-i} + \sum_{i=0}^{p} a_{2i}\Delta Y_{t-i} + \sum_{i=0}^{p} a_{3i}\Delta Y_{t-i}^2 + \sum_{i=0}^{p} a_{4i}\Delta E_{t-i} + \sum_{i=0}^{p} a_{5i}\Delta F_{t-i} + \sum_{i=0}^{p} a_{6i}\Delta T_{t-i}$$
$$+ \lambda_1 CO_{2t-1} + \lambda_2 Y_{t-1} + \lambda_3 Y_{t-1}^2 + \lambda_4 E_{t-1} + \lambda_5 F_{t-1} + \lambda_6 T_{t-1} + \varepsilon_t \text{......(2)}$$

Where Δ and ε_t are the first difference operator and the residual term, respectively. β_0 is the intercept component, and the variable CO_2, Y, Y^2, E, F and T are defined earlier. The summation signs represent the error correction dynamics, while this part of the equation ($\lambda_1 CO_{2t-1} + \lambda_2 Y_{t-1} + \lambda_3 Y_{t-1}^2 + \lambda_4 E_{t-1} + \lambda_5 F_{t-1} + \lambda_6 T_{t-1}$) corresponds to the long run relationship. This equation includes the time trend variable to capture the autonomous time-related changes. The selection of lag based on a criterion such as Akaike information criterion and Schwarz Bayesian Criterion.

The bounds testing procedure is based on the joint F-statistic or Wald statistic that test the null hypothesis, which means there is no co-integration. If the value of F-statistics higher than the upper level of the band, the null hypothesis is rejected, and so there is co-integration. If the value of F-statistics is lower than the upper level of the band, then we cannot reject the null hypothesis and so there is no co-integration.

Recently, Narayan (2005) argues that existing critical values which are based on large sample sizes cannot be used for small sample sizes. Therefore, the author regenerates the set of critical values for the limited data ranging from 30–80 observations by using the Pesaran *et al.* (2001). Since this study employs limited annual time series data then the critical values of Narayan (2005) can be used for the bounds F-test instead of Pesaran *et al.* (2001).

If a long-run relationship exists between variables, the next step is to estimate the error-correction model:

$$\Delta CO_2 = \beta_0 + \sum_{i=1}^{p} a_{1i} \Delta CO_{2t-i} + \sum_{i=0}^{p} a_{2i} \Delta Y_{t-i} + \sum_{i=0}^{p} a_{3i} \Delta Y_{t-i}^2 + \sum_{i=0}^{p} a_{4i} \Delta E_{t-i} + \sum_{i=0}^{p} a_{5i} \Delta F_{t-i} + \sum_{i=0}^{p} a_{6i} \Delta T_{t-i}$$
$$+ \eta_1 ECT_{t-1} + \varepsilon_{1t} \ldots\ldots(3)$$

Where η measures the speed of adjustment to obtain equilibrium in the event of shock(s) to the system, and ECT_{t-1} are the residuals obtained from the estimated co-integration model of Eq. (1).

Diagnostic and stability tests are conducted to measure the suitability of the specification of the model. In other words, diagnostic tests examine the model for serial correlation, heteroscedasticity and normality. As suggested by Pesaran and Pesaran (1997), the stability of the long run and short-run coefficients are tested through the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) tests proposed by Brown et al. (1975). If the plots of the CUSUM and CUSUMSQ statistics stay within the critical bonds of a 5% level of significance, then the null hypothesis of all coefficients that are obtained from regression is stable and cannot be rejected.

5.4 Granger Causality

The ARDL technique examines the existence of co-integration relationship between variables, but it fails to show the direction of the causal relationship. If we do not find any indication for co-integration among the variables then the description of the Granger causality test will be a vector auto regression (VAR) in first difference form. If the variables are found to be co-integrated then we need to augment the Grangertype causality test model with a one period lagged error correction term (ECT_{t-1}). Engle and Granger (1987) indicate that the Granger causality test, which is conducted in the first-differenced variables by means of a VAR, will be ambiguous in the presence of co-integration. Hence, an inclusion of an added variable to the VAR system, such as the error correction term would support us to capture the long-run relationship. The augmented form of Granger causality test with ECM is expressed in multivariate qth order of VECM Model as follows:

$$(1-B)\begin{bmatrix} CO_{2t} \\ Y_t \\ Y_t^2 \\ E_t \\ F_t \\ T_t \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \\ b_6 \end{bmatrix} + \sum_{i=1}^{q}(1-B)\begin{bmatrix} c_{11,i} & c_{12,i} & c_{13,i} & c_{14,i} & c_{15,i} & c_{16,i} \\ c_{21,i} & c_{22,i} & c_{23,i} & c_{24,i} & c_{25,i} & c_{26,i} \\ c_{31,i} & c_{32,i} & c_{33,i} & c_{34,i} & c_{35,i} & c_{36,i} \\ c_{41,i} & c_{42,i} & c_{43,i} & c_{44,i} & c_{45,i} & c_{46,i} \\ c_{51,i} & c_{52,i} & c_{53,i} & c_{54,i} & c_{55,i} & c_{56,i} \\ c_{61,i} & c_{62,i} & c_{63,i} & c_{64,i} & c_{65,i} & c_{66,i} \end{bmatrix}\begin{bmatrix} CO_{2t-i} \\ Y_{t-i} \\ Y_{t-i}^2 \\ E_{t-i} \\ F_{t-i} \\ T_{t-i} \end{bmatrix} + \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \end{bmatrix}\left[ECT_{t-1}\right] + \begin{bmatrix} \delta_{1t} \\ \delta_{2t} \\ \delta_{3t} \\ \delta_{4t} \\ \delta_{5t} \\ \delta_{6t} \end{bmatrix} \text{......(44)}$$

Where (1-B) is the lag operator, ECT_{t-1} is the lagged error-correction term, which is attained from the long-run relationship defined in Eq. (1) and δ_t serially independent random errors.

The VECM allows us to capture both the long-run and short-run causality. The short run causal effects can be obtained by the F-test of the lagged independent variables, but the t-statistics on the coefficient of the lagged error correction term shows the significance of the long-run causal effect.

Chapter 6: Empirical Results

6.1 Unit Root Tests

As argued earlier, the ARDL bounds testing technique can be applied regardless of whether the variables are I (0), I (1) or fractionally co-integrated (Pesaran and Pesaran, 1997). However, according to Ouattara (2004), in the existence of I (2) variables the computed F-statistics provided by Pesaran et al. (2001) become invalid. Consequently, the execution of unit root tests in the ARDL technique is important to guarantee that none of the variables is integrated at an order of I (2) or beyond. For this purpose, this study uses the conventional Augmented Dicky Fuller (ADF) tests. The null hypothesis states that there exist unit roots. In contrast, the alternative hypothesis states that there is no unit root (the series is stationarity). The Dickey Fuller regressions include an intercept in the levels, and include an intercept in the first differences. We tested each variable for a unit root at the 5 percent levels of significance.

According to the unit-root test, table (1) shows that the null hypothesis is not rejected, meaning that the variables are nonstationary, hence, all variables have unit root test. This is because the absolute value of the t-statistics is lower than the MacKinnon (or ADF) critical value at 5% level of significance, in other words, t-statistics< critical value at 5% level of significance.

Table 1: ADF Test at Levels (at Intercept)

Variables	t-statistics	Critical value at 5%
CO_2	0.796	-2.986
Y	-0.262	-2.971
Y^2	-0.233	-2.971
E	-0.824	-2.967
F	-0.976	-2.986
T	0.652	-2.957

In the contrary, table (2) shows that all variable under study are stationary at first difference, where the t-statistics are higher than the MacKinnon (or ADF) critical value at 5% level of significance. Therefore, it can be concluded that all series are I (1), because they became stationary at first difference.

Table 2: ADF Test at First Difference (at Intercept)

Variable	t-statistics	Critical value at 5%
CO2	-3.67	-2.981
Y	-3.67	-2.967
Y^2	-3.31	-2.967
E	-6.24	-2.982

F	-5.06	-2.960
T	-3.11	-2.960

6.2 Co-integration Test Results

The co-integration test requires that the variables under consideration are not integrated at an order higher than one. Based on the Akaike Information (AIC) and the Schwarz–Bayesian criteria (SBC) information, the optimal number of lags of the model is selected as suggested by Pesaran et al. (2001). The results of these criteria show that the optimal number of lags is one.

Table (3) presents the calculated F-statistics, together with the critical values, are reported in Table 3. The F-test has a non-standard distribution that depends on four factors: the order of variables included in the ARDL model, the number of explanatory variables, whether the ARDL model includes an intercept and time trend, and the sample size.

Table 3: The Results of F-test for Co-integration

Model	**F-statistics**	**Conclusion**

F($CO2$ / Y Y^2 E F T)	4.245172	Co-integration

Note: The critical value ranges of *F*-statistics are 2.306-3.353, 2.734-3.920 and 3.657-5.256 at 10%, 5% and 1% level of significances, respectively, which are taken from Appendix in Narayan (2005).

The computed F-statistic F ($CO2$ / Y Y^2 E F T) is 4.245172, which is greater than the upper bound of the critical value of 3.920 at the 5% significance level. Hence, at the 5% level, it is concluded that the null hypothesis is rejected, so there is a co-integration among variables.

6.3 Long run and Short-run Elasticity's

Given the presence of a long-run relationship, the ARDL co-integration procedure was implemented to estimate Eq. (2) with maximum order of lag set to 1. The AIC criterion has been used to determine the coefficients of the level variables. As AIC is a good criterion, since it selects the smallest possible lag length and minimizes the loss of degree of freedoms as well. The long-run results are reported in table 4, where all estimated coefficients are statistically significant at 5% level of significance.

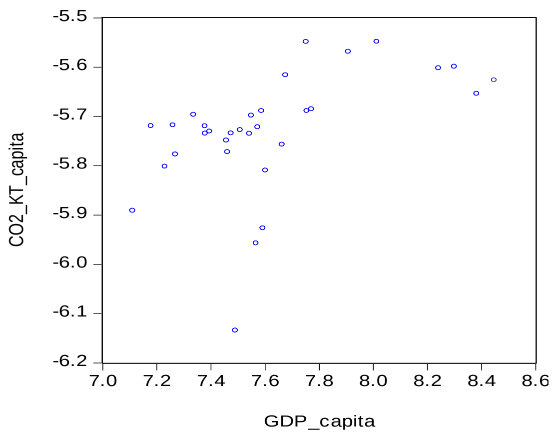
Table 4: Long-run Estimation Results (of CO_2 Emissions)

Regressor	**Coefficient**
Y	9.113957*** (3.097399)
Y^2	-0.605954*** (0.204776)
E	0.453831*** (0.226475)
F	-0.798910*** (0.331434)
T	0.216487*** (0.103545)
Constant	40.58031*** (12.94523)

Note: The asterisks *** is 5% significant level. The numbers in parentheses are standard error.

Under the EKC hypothesis, the long-run elasticity of per capita carbon emissions with respect to per capita income and the square of per capita income expected to be $\beta_1>0$ and $\beta_2<0$ respectively. This implies that both linear and non-linear terms of GDP give proof in support to inverted-U shaped relationship between economic growth and CO_2 emissions. As per capita GDP increases, per capita carbon emissions increase as well, until some threshold level of per capita GDP is achieved, then carbon emissions begin to decline. Specifically, results indicate that a 1% rise in GDP will raise CO_2 emissions by 9.11%. These evidences support the EKC hypothesis, revealing the fact that CO_2 emissions increase in the initial stage of economic growth but decline after a threshold point. This finding is consistent with the result of [Agras *et al.* (1999), Fodha and Zaghdoud (2010), Song *et al.*(2008), Halicioglu (2009), Lean and Smyth (2010) and Ozturk and Acaravci (2013) and Shahbaz *et al.* (2012)].

Figure 9: Time series plots of the Variables: the Relationship between Per Capita CO_2 Emissions and Per Capita GDP.



In Figure.3.We observe an inverse U-shaped between per capita GDP and per capita CO_2 emissions. This is consistent with the prediction of the EKC hypothesis. Hence, the use of a quadratic specification is important to catch the long-run relationship of these variables.

The long-run estimates of per capita carbon emissions with respect to per capita financial development expected to be $\beta_4<0$, the results indicate that financial development has a long-run negative impact on per capita CO_2 emissions. A 1% rise in domestic credit to private sector will lead to about 0.80% decline in per capita CO_2 emissions. This suggests that the financial sector enhances environmental quality by empowering firms in embracing advanced cleaner and environment friendly techniques. This result is consistent with the findings of [Omri et al. (2015), Tamazian et al. (2009), Sadorsky (2010), Dizaji and Ousla and Ozturk and Acaravci (2013)]. However these results differ for Zhang (2011), who noted that the bank loans give strong backing to organizations to access external finance and enhance investment scale, which increases carbon emissions.

The long-run estimates of per capita carbon emissions with respect to per capita energy consumption expected to be $\beta_3>0$. This means that the increase in per capita energy consumption leads to increase in per capita carbon emissions. The coefficient of energy consumption β_3 is about 0.45%, which is consistent with the result of [Boutabba, 2013; Ozturk and Acaravci, 2013; Jalil and Feridun, 2011; Shahbaz *et al*., 2011; Soytas *et al*., 2007; Ang, 2007].

In addition, the coefficient of openness variable is also positive and significant at 5% significance level. It shows that a rise in foreign trade to GDP ratio results in an increase in per capita carbon emissions, which is consistent with the findings of [Omri et al. (2015); Ozturk and Acaravci, 2013; Jalil and Feridun, 2011].

The short run dynamics results are reported in table 5. The signs of coefficients of Y and Y^2 support again the EKC hypothesis in the short run, which is consistent with the result of [Boutabba, 2013]. Most variables in short run are not significant. Energy consumption and financial development do not have any effect on CO_2 emission in short-run. The trade openness ratio has a negative coefficient and not significant. The finding on the trade openness is not significant, which is consistent with that of Jalil and Mahmud (2009) about China.

Table 5: Short-run Estimation Results (of CO_2 Emissions)

Regressor	**Coefficient**
ΔY	2.208797 (2.899412)
ΔY^2	-0.146064 (0.190980)
ΔE	-0.145191 (0.317566)
ΔF	0.310848

	(0.185944)
ΔT	-0.117686 (0.110484)
Δconstant	0.022499 (0.014702)
ECM(-1)	-0.507775** (0.146489)
R^2	0.4926
S.E of regression	0.0540
Diagnostic test	**P-value**
Serial correlation LM Test	0.6811
Histogram-Normality Test	0.724
Heteroscedasticity-Test	0.430

Note: The asterisks ** is 5% significant level. The numbers in parentheses are standard error.

The coefficients of estimated ECM are also negative and statistically significant at 5% confidence level. These values show that the whole system adjust at speed of 50% (the whole system can get back to long-run equilibrium at a speed of 50%). In other words, these values indicate that any deviation from the long-run equilibrium between variables is revised for every period to get back to the long-run equilibrium level.

As shown in the table, there is no presence for heteroscedasticity or autocorrelation in the residuals of the model over the sample period. This indicates that the results of the diagnostic tests indicates that the model have the desired econometric properties.

In addition, due to the structural changes in Jordanian economy, it is likely that macroeconomic series may be subject to one or multiple structural breaks. For this reason, the stability of the short-run and the long-run coefficients are checked through CUSUM CUSUMSQ tests proposed by Brown et al. (1975). The charts representing the CUSUM and CUSUM of Squares tests are displayed in Figs. 1 and 2 respectively.

Figure 10: Plot of Cumulative Sum

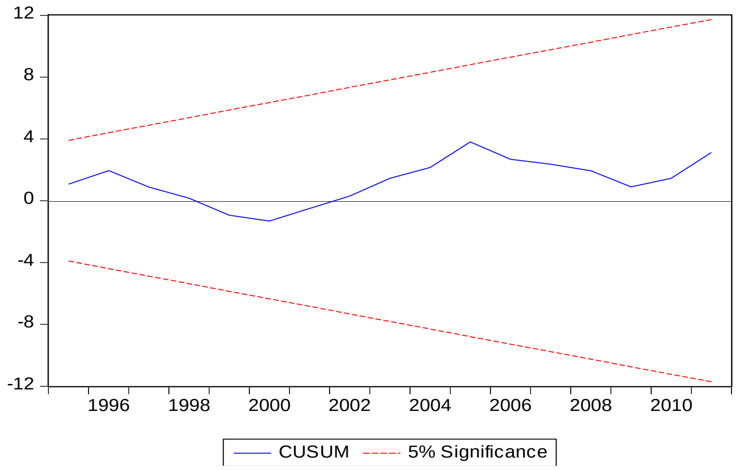


Figure 11: Plot of Cumulative Sum of Squares

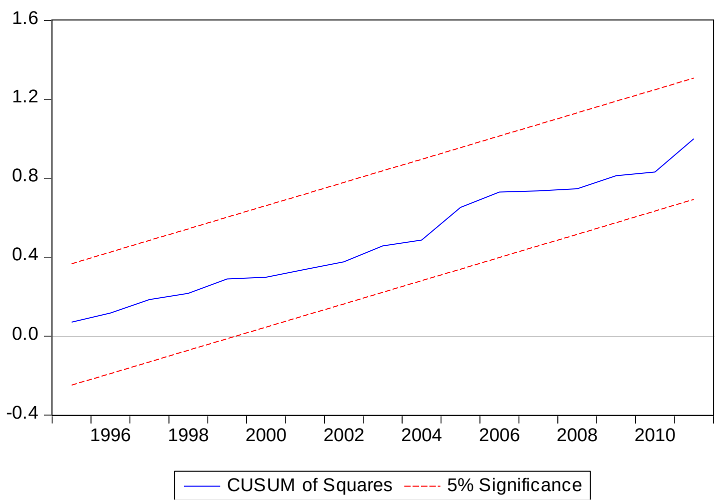


Figure 1 and 2 present the plot of CUSUM and CUSUMSQ tests statistics that are located inside the critical bounds of 5% significance level. This suggests that the assessed parameters are steady over the periods.

6.4 Granger Causality Results

According to the results obtained from the test of co-integration show that there exist co-integration between variables, so this suggests that there must be Granger causality in at least one direction, but it does not indicate the direction of temporal causality between the variables. The short run and long run Granger causality are estimated and the result can be summarized in table 6.

Table 6: Long-run Granger Causality Results

# of equation	Dependent variable	Long run γ_i
1.	ΔCO_2	-0.369659** (0.099686)
2.	ΔY	-0.003910 (0.201298)
3.	ΔY^2	0.159451 (3.039706)
4.	ΔE	-0.194400*** (0.097704)
5.	ΔF	0.030871

		(0.085490)
6.	ΔT	0.381134 *** (0.195849)

Notes: *** and ** indicate that the null hypothesis of no causation is rejected at the 10% and 5% significance levels, respectively. The numbers in parentheses are standard errors. Δ is the first difference operator. The number of appropriate lag is one according to Akaike information criterion, Schwarz information criterion.

Table 6 summarizes the results of the long-run Granger causality. According to the result related to coefficient on the lagged error-correction term, the error-correction term is statistically significant in the carbon emission equation (#1), so there exists a long-run relationship among the GDP, square of GDP, financial development, energy consumption and trade openness. This means that in the long run, energy consumption, GDP, squared GDP, financial development and foreign trade Granger-cause CO_2 emissions. This provides the existence of a unidirectional long-run causality from per capita GDP, the square of per capita GDP, per capita energy use and financial development to per capita carbon emissions. There exists another long-run Granger causality which runs intuitively through the error-correction terms from CO_2 emissions, income, squared income, financial development and foreign trade to the energy consumption since the ECT significant in energy equation at 10% level of significant.

Table 7: Short-run Granger Causality Results

#	Dependent variable	ΔCO_2	ΔY	ΔY^2	ΔE	ΔF	ΔT
1.	ΔCO_2	____	-4.502545 (2.995926)	0.304597 (0.198020)	-0.185887 (0.311736)	0.124236 (0.181257)	-0.137596 (0.107358)
2.	ΔY	0.089367 (0.566058)	____	0.468592 (0.434149)	-0.066011 (0.679458)	0.199983 (0.392357)	-0.122877 (0.236246)
3.	ΔY^2	1.330279 (8.547772)	-106.6809 (99.15357)	____	-0.606514 (10.26017)	3.188689 (5.924791)	-1.811426 (3.567440)
4.	ΔE	0.041264 (0.274747)	-5.165204 (3.187042)	0.348375)*** (0.210722)	____	0.251249 (0.190437)	-0.042023 (0.114666)
5.	ΔF	-0.067720 (0.240400)	5.416128*** (2.788625)	-0.351515*** (0.184379)	0.416307 (0.288560)	____	0.013101 (0.100332)
6.	ΔT	-0.390841 (0.550736)	3.747812 (6.388496)	-0.240525 (0.422397)	0.687086 (0.661066)	0.307705 (0.381736)	____

Notes: *** and ** indicate that the null hypothesis of no causation is rejected at the 10% and 5% significance levels, respectively.

Table 7 summarizes the results of short-run Granger causality. With short run effect, per capita GDP, the square of per capita GDP, financial development, energy consumption and Trade are not statistically significant in the carbon emissions equation (#1). This implies that these variables do not Granger cause per capita carbon emissions in the short-run. In the energy use equation (#4), the square of per capita GDP is statistically significant, implying that the square of per capita GDP Granger cause per capita energy consumption in the short run. In financial development equation (#5), the per capita GDP, the square of per capita GDP are significant at 10% level. This implies that these variables Granger cause per capita financial development in the short-run. In sum, in the short run there is no Granger causality from per capita income, the square of per capita income, financial development, energy consumption and trade openness to per capita carbon emission. However, there is unidirectional causality from the per capita GDP, the square of per capita GDP to financial development and from the square of per capita GDP to per capita energy consumption.

The per capita energy consumption is finding that Granger causes per capita carbon emissions in the long run, but not vice versa. That is, an increase in energy consumption will boost carbon emissions. This implies that reducing energy use is an appropriate way to decrease carbon emissions.

Chapter 7: Conclusions and Recommendations

7.1 Conclusions

This study examines the causal relationship between financial development, income, energy consumption, trade openness and carbon emissions in Jordan covering the period between1980 and 2011. The study uses the time-series data collected from the World Bank and UNCTAD databases. The bounds F-test for co-integration test yields a proof of a long-run relationship between per capita carbon emissions, per capita energy consumption, per capita GDP, the square of per capita GDP, financial development and trade openness. The results also support the validity of EKC hypothesis in the Jordanian economy, that is, the level of CO_2 emissions initially increased with income, until it achieved its stabilization point, and then it decreased in Jordan. The long-run elasticity of CO_2 emissions with respect to energy consumption is positive. Furthermore, the relationship between CO_2 emissions and

GDP in the long run is positive, and negative with respect to square of GDP. In addition to that, the foreign trade has positive impact on CO_2 emissions.

The findings show that financial development has a long-run negative impact on per capita CO_2 emissions, suggesting that financial development does not increase environmental degradation, but works on enhancing environmental quality by promoting firms to use advanced environment friendly techniques. The coefficient of estimated ECT is negative, significant and equal 0.50.

Causality tests clearly justify the long run effects of energy consumption, GDP, squared GDP, financial development and foreign trade Granger-cause on CO_2 emissions which explains the existence of a unidirectional long-run causality from per capita GDP, the square of per capita GDP, per capita energy use and financial development to per capita carbon emissions.

7.2 Recommendations

Based on the above conclusions, the study recommends a number of things that should take into consideration the environment and its problems in order to find ways to alleviate pressure on environmental resources, given that the environment is the foundation of any sustained economic growth so, the study recommend:

1. Reduction of the usage of polluting energy, which result from the burning of oil and its derivatives, and using the environmentally-friendly sources such as wind and sun based on the energy consumption result.

2. The import of production techniques that are less polluting to the environment, including the reduction of fuel imports, as it is the main polluter of the environment, and focusing on the imports of electric cars, and light electric rail instead of traditional polluting vehicles based on the trade openness result.

3. The government should establish light train systems, and enacted policies to reduce sales taxes, customs, and any other fees for vehicles with small engines based on the trade openness result.

4. Encouraging the financial sector to focus on improving the quality of the environment through granting them loans that contribute to the investment in low pollution projects that help in protecting the environment and enabling firms in adopting advanced cleaner and environment friendly techniques.

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Appendix

Appendix 1: Raw Data

Table 1: The Raw data of the Study during the Period 1980-1999

Year	Financial development	EXPORT	IMPORT	GDP_ capita (current)	CO2_ Kt	CO2 Emissions (Metric Tons per capita)	Energy_ Cons
1980	46.5	1578.088	3230.46	1792.6221	4726.763	2.1672458	698
1981	47.7	1893.242	4201.39	1933.7325	5863.533	2.5861918	836
1982	51.1	1863.617	4255.44	1983.5422	6292.572	2.6666209	914
1983	55.6	1704.499	3859.56	2003.624	7363.336	2.9982279	953

1984	59.4	1882.89	3802.84	1946.9134	8353.426	3.2741829	1,009
1985	60.7	1955.971	3713.65	1888.6206	8540.443	3.2301222	990
1986	57.9	1790.82	3308.9	2333.0911	9281.177	3.3823531	1,023
1987	59.2	2224.779	3698.38	2374.0047	9662.545	3.3951318	1,046
1988	62.5	2428.07	3759.21	2129.3526	9314.18	3.1594912	1,001
1989	64.7	2348.68	2945.78	1381.257	9233.506	3.0214352	973
1990	62.3	2510.98	3568.56	1312.2803	10403.279	3.2817915	1,033
1991	62.4	2480.7	3424.67	1225.5197	9798.224	2.763956	954
1992	55.9	2668.15	4323.37	1422.7668	12266.115	3.2858599	1,019
1993	60.7	2819.97	4492.31	1435.2888	12101.1	3.0980799	964
1994	64.5	2986.43	4396.56	1535.9887	13633.906	3.357278	994
1995	68.9	3478.76	4902.77	1603.6822	13556.899	3.2316803	1,025
1996	69.4	3663.19	5415.79	1601.9328	14187.623	3.2803753	1,021
1997	70	3572.35	5185.76	1630.1537	14418.644	3.2445194	1,014
1998	69.1	3627.51	5187.73	1733.2649	14543.322	3.1865298	1,022
1999	71.4	3533.57	4989.99	1740.9176	14568.991	3.1130323	993

Table 1: The Raw data of the Study during the Period 2000-2011

Year	Financial development	EXPORT	IMPORT	GDP_ capita (current)	CO2_ Kt	CO2 Emissions (Metric Tons per capita)	Energy_ Cons
2000	72.1	3538.95	5795.86	1763.1695	15507.743	3.2328003	1,014
2001	75.7	3781.9	6027.35	1824.8861	16002.788	3.2545837	980
2002	72.8	4544.15	6383.8	1901.5804	16886.535	3.3518331	1,004
2003	70.8	4829.9	6967.17	1973.8621	17469.588	3.3829566	1,002
2004	74.7	5955.71	9406.91	2156.4398	19240.749	3.6371926	1,176
2005	88.1	6634.98	11859.38	2326.4952	21059.581	3.8919943	1,234
2006	91.8	8111.85	13230.86	2719.8224	21121.92	3.8153757	1,238
2007	91.6	9279.83	15700.55	3022.5429	22035.003	3.8924224	1,274
2008	80.9	12415.13	19228.53	3797.5926	21349.274	3.6898158	1,222
2009	75.5	10929.33	16458.71	4026.7664	21891.99	3.7010972	1,261

2010	73.2	12628.31	18241.51	4370.721	21180.592	3.5032405	1,175
2011	73.5	13146.62	21301.127	4665.9543	22258.69	3.6011471	1,143

Appendix 2: Statistical Tests Tables

Table 1: ADF test at levels (at intercept) for CO_2

Null Hypothesis: LNCO2_KT__CAPITA has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on AIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.796401	0.8028
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF test at First Difference (at intercept) for CO_2

Null Hypothesis: D(LNCO2_KT__CAPITA) has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on AIC, maxlag=7)

		t-Statistic
Augmented Dickey-Fuller test statistic		-3.67533(
Test critical values:	1% level	-3.72407(
	5% level	-2.986225
	10% level	-2.63260(

*MacKinnon (1996) one-sided p-values.

Table 1: ADF test at levels (at intercept) for GDP

Null Hypothesis: LNGDP__CAPITA__CURRENT_ has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.262494	0.9187
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF test at First Difference (at intercept) for GDP

Null Hypothesis: D(LNGDP__CAPITA__CURRENT_) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.431963	0.0179
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Table 1: ADF test at levels (at intercept) for GDP Squared

Null Hypothesis: LNGDP_SQUARED has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.233653	0.9229
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF test at First Difference (at intercept) for GDP Squared

Null Hypothesis: D(LNGDP_SQUARED) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.319893	0.0231
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

*MacKinnon (1996) one-sided p-values.

Table 1: ADF Test at Levels(at Intercept) for Energy Consumption

Null Hypothesis: LNENERGY__CONS_CAPITA has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=8)

		t-Statistic	
Augmented Dickey-Fuller test statistic		-0.824321	(
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF Test at First Difference (at Intercept) for Energy Consumption

Null Hypothesis: D(LNENERGY__CONS_CAPITA) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=8)

		t-Statistic
Augmented Dickey-Fuller test statistic		-6.244874
Test critical values:	1% level	-3.661661
	5% level	-2.960411
	10% level	-2.619160

*MacKinnon (1996) one-sided p-values.

Table 1: ADF Test at Levels (at Intercept) for Financial Development

Null Hypothesis: LNFINC_DEV_CAPITA has a unit root

Exogenous: Constant
Lag Length: 7 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.976005	0.7457
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF Test at First Difference (at Intercept) for Financial Development

Null Hypothesis: D(LNFINC_DEV_CAPITA) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=8)

		t-Statistic
Augmented Dickey-Fuller test statistic		-5.065109
Test critical values:	1% level	-3.679322
	5% level	-2.967767
	10% level	-2.622989

*MacKinnon (1996) one-sided p-values.

Table 1: ADF Test at Levels (at Intercept) for Trade Openness

Null Hypothesis: LNTRADE_CAPITA has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.657685	0.9892
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

*MacKinnon (1996) one-sided p-values.

Table 2: ADF Test at First Difference (at Intercept) for Trade Openness

Null Hypothesis: D(LNTRADE_CAPITA) has a unit root
Exogenous: Constant

Lag Length: 1 (Automatic - based on AIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.108909	0.0366
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

Table 3: The results of F-test for co-integration

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	4.245172	(6, 17)	0.0086
Chi-square	25.47103	6	0.0003

Null Hypothesis: C(8)=C(9)=C(10)=C(11)=C(12)=C(13)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(8)	-0.462473	0.135990
C(9)	0.453831	0.226475
C(10)	-0.798910	0.331434
C(11)	9.113957	3.097399
C(12)	-0.605954	0.204776
C(13)	0.216487	0.103545

Restrictions are linear in coefficients.

Table 4: Long-run Estimation Results

Dependent Variable: D(LNCO2_KT__CAPITA)
Method: Least Squares
Date: 04/14/16 Time: 10:43
Sample (adjusted): 1982 2011
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic
C	-40.58031	12.94523	-3.134770

D(LNCO2_KT__CAPITA(-1))	-0.059802	0.266209	-0.224644	0.8249
D(LNENERGY__CONS_CAPITA(-1))	-0.572306	0.349821	-1.635996	0.1202
D(LNFINC_DEV_CAPITA(-1))	0.261870	0.214650	1.219988	0.2391
D(LNGDP__CAPITA__CURRENT_(-1))	-10.37512	4.861810	-2.134003	0.0477
D(LNGDP_SQUARED(-1))	0.683510	0.320649	2.131646	0.0479
D(LNTRADE_CAPITA(-1))	-0.220892	0.116178	-1.901323	0.0743
LNCO2_KT__CAPITA(-1)	-0.462473	0.135990	-3.400795	0.0034
LNENERGY__CONS_CAPITA(-1)	0.453831	0.226475	2.003893	0.0613
LNFINC_DEV_CAPITA(-1)	-0.798910	0.331434	-2.410464	0.0275
LNGDP__CAPITA__CURRENT_(-1)	9.113957	3.097399	2.942455	0.0091
LNGDP_SQUARED(-1)	-0.605954	0.204776	-2.959100	0.0088
LNTRADE_CAPITA(-1)	0.216487	0.103545	2.090751	0.0519

R-squared	0.685994	Mean dependent var	0.011036
Adjusted R-squared	0.464343	S.D. dependent var	0.066121
S.E. of regression	0.048393	Akaike info criterion	-2.920239
Sum squared resid	0.039812	Schwarz criterion	-2.313053
Log likelihood	56.80359	Hannan-Quinn criter.	-2.725995
F-statistic	3.094924	Durbin-Watson stat	1.841713
Prob(F-statistic)	0.016721		

Table 5: Short-run Estimation Results

Dependent Variable: D(LNCO2_KT__CAPITA)
Method: Least Squares
Date: 04/14/16 Time: 14:04
Sample (adjusted): 1982 2011
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic
C	0.022499	0.014702	1.530287
D(LNCO2_KT__CAPITA(-1))	-0.104117	0.280659	-0.370975
D(LNENERGY__CONS_CAPITA(-1))	-0.145191	0.317566	-0.457200
D(LNFINC_DEV_CAPITA(-1))	0.310848	0.185944	1.671728
D(LNGDP__CAPITA__CURRENT_(-1))	2.208797	2.899412	-0.761808
D(LNGDP_SQUARED(-1))	-0.146064	0.190980	0.764815
D(LNTRADE_CAPITA(-1))	-0.117686	0.110484	-1.065186
ECT(-1)	-0.507775	0.146489	-3.466293

R-squared	0.492622	Mean dependent var
Adjusted R-squared	0.331183	S.D. dependent var
S.E. of regression	0.054075	Akaike info criterion
Sum squared resid	0.064329	Schwarz criterion
Log likelihood	49.60592	Hannan-Quinn criter.

F-statistic	3.051452	Durbin-Watson stat	1.684906
Prob(F-statistic)	0.021107		

Table 6: Long run Granger causality results

Dependent Variable: D(LNCO2_KT__CAPITA)
Method: Least Squares
Date: 04/15/16 Time: 12:06
Sample (adjusted): 1982 2011
Included observations: 30 after adjustments
D(LNCO2_KT__CAPITA) = C(1)*(LNCO2_KT__CAPITA(-1) -
10.6801254867*LNGDP__CAPITA__CURRENT_(-1) +
0.710436553367*LNGDP_SQUARED(-1) - 0.147727992789
*LNENERGY__CONS_CAPITA(-1) + 0.17696470122
*LNFINC_DEV_CAPITA(-1) - 0.307477706315*LNTRADE_CAPITA(-1)
+ 44.6558674507) + C(2)*D(LNCO2_KT__CAPITA(-1)) + C(3)
*D(LNGDP__CAPITA__CURRENT_(-1)) + C(4)*D(LNGDP_SQUARED(
-1)) + C(5)*D(LNENERGY__CONS_CAPITA(-1)) + C(6)
*D(LNFINC_DEV_CAPITA(-1)) + C(7)*D(LNTRADE_CAPITA(-1)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.369659	0.099686	-3.708255	0.0012
C(2)	-0.285026	0.265230	-1.074639	0.2942
C(3)	-4.502545	2.995926	-1.502889	0.1471
C(4)	0.304597	0.198020	1.538217	0.1383
C(5)	-0.185887	0.311736	-0.596297	0.5571
C(6)	0.124236	0.181257	0.685413	0.5002
C(7)	-0.137596	0.107358	-1.281655	0.2133
C(8)	0.008819	0.015018	0.587236	0.5630

R-squared	0.517259	Mean dependent var	0.011036
Adjusted R-squared	0.363659	S.D. dependent var	0.066121
S.E. of regression	0.052745	Akaike info criterion	-2.823504
Sum squared resid	0.061206	Schwarz criterion	-2.449851
Log likelihood	50.35255	Hannan-Quinn criter.	-2.703969
F-statistic	3.367580	Durbin-Watson stat	1.703696
Prob(F-statistic)	0.013515		

Dependent Variable: D(LNGDP__CAPITA__CURRENT_)
Method: Least Squares
Date: 04/15/16 Time: 12:20
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
D(LNGDP__CAPITA__CURRENT_) = C(9)*(LNCO2_KT__CAPITA(-1) -
10.6801254867*LNGDP__CAPITA__CURRENT_(-1) +
0.710436553367*LNGDP_SQUARED(-1) - 0.147727992789

*LNENERGY__CONS_CAPITA(-1) + 0.17696470122
*LNFINC_DEV_CAPITA(-1) - 0.307477706315*LNTRADE_CAPITA(-1)
+ 44.6558674507) + C(10)*D(LNCO2_KT__CAPITA(-1)) + C(11)
*D(LNGDP__CAPITA__CURRENT_(-1)) + C(12)*D(LNGDP_SQUARE
D(-1)) + C(13)*D(LNENERGY__CONS_CAPITA(-1)) + C(14)
*D(LNFINC_DEV_CAPITA(-1)) + C(15)*D(LNTRADE_CAPITA(-1)) +
C(16)

	Coefficient	Std. Error	t-Statistic	Prob.
C(9)	-0.003910	0.201298	-0.019424	0.9847
C(10)	0.089367	0.566058	0.157877	0.8759
C(11)	-6.693868	6.566236	-1.019438	0.3186
C(12)	0.468592	0.434149	1.079337	0.2916
C(13)	-0.066011	0.679458	-0.097153	0.9234
C(14)	0.199983	0.392357	0.509697	0.6151
C(15)	-0.122877	0.236246	-0.520121	0.6079
C(16)	0.010905	0.033132	0.329129	0.7450

R-squared	0.183326	Mean dependent var	0.029971
Adjusted R-squared	-0.065226	S.D. dependent var	0.112753
S.E. of regression	0.116372	Akaike info criterion	-1.246405
Sum squared resid	0.311479	Schwarz criterion	-0.876344
Log likelihood	27.31928	Hannan-Quinn criter.	-1.125775
F-statistic	0.737575	Durbin-Watson stat	1.953962
Prob(F-statistic)	0.642800		

Dependent Variable: D(LNGDP_SQUARED)
Method: Least Squares
Date: 04/15/16 Time: 12:22
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
D(LNGDP_SQUARED) = C(17)*(LNCO2_KT__CAPITA(-1) -
10.6801254867*LNGDP__CAPITA__CURRENT_(-1) +
0.710436553367*LNGDP_SQUARED(-1) - 0.147727992789
*LNENERGY__CONS_CAPITA(-1) + 0.17696470122
*LNFINC_DEV_CAPITA(-1) - 0.307477706315*LNTRADE_CAPITA(-1)
+ 44.6558674507) + C(18)*D(LNCO2_KT__CAPITA(-1)) + C(19)
*D(LNGDP__CAPITA__CURRENT_(-1)) + C(20)*D(LNGDP_SQUARE
D(-1)) + C(21)*D(LNENERGY__CONS_CAPITA(-1)) + C(22)
*D(LNFINC_DEV_CAPITA(-1)) + C(23)*D(LNTRADE_CAPITA(-1)) +
C(24)

	Coefficient	Std. Error	t-Statistic	Prob.
C(17)	0.159451	3.039706	0.052456	0.9586
C(18)	1.330279	8.547772	0.155629	0.8777
C(19)	-106.6809	99.15357	-1.075915	0.2931
C(20)	7.444798	6.555869	1.135593	0.2678
C(21)	-0.606514	10.26017	-0.059113	0.9534

C(22)	3.188689	5.924791	0.538194	0.5956
C(23)	-1.811426	3.567440	-0.507767	0.6165
C(24)	0.191436	0.500307	0.382636	0.7055

R-squared	0.194356	Mean dependent var	0.481443
Adjusted R-squared	-0.050840	S.D. dependent var	1.714249
S.E. of regression	1.757285	Akaike info criterion	4.183053
Sum squared resid	71.02516	Schwarz criterion	4.553114
Log likelihood	-56.83732	Hannan-Quinn criter.	4.303684
F-statistic	0.792655	Durbin-Watson stat	1.960448
Prob(F-statistic)	0.600967		

Dependent Variable: D(LNENERGY__CONS_CAPITA)
Method: Least Squares
Date: 04/15/16 Time: 12:23
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
D(LNENERGY__CONS_CAPITA) = C(25)*(LNCO2_KT__CAPITA(-1) - 10.6801254867*LNGDP__CAPITA__CURRENT_(-1) + 0.710436553367*LNGDP_SQUARED(-1) - 0.147727992789 *LNENERGY__CONS_CAPITA(-1) + 0.17696470122 *LNFINC_DEV_CAPITA(-1) - 0.307477706315*LNTRADE_CAPITA(-1) + 44.6558674507) + C(26)*D(LNCO2_KT__CAPITA(-1)) + C(27) *D(LNGDP__CAPITA__CURRENT_(-1)) + C(28)*D(LNGDP_SQUARED(-1)) + C(29)*D(LNENERGY__CONS_CAPITA(-1)) + C(30) *D(LNFINC_DEV_CAPITA(-1)) + C(31)*D(LNTRADE_CAPITA(-1)) + C(32)

	Coefficient	Std. Error	t-Statistic	Prob.
C(25)	-0.194400	0.097704	-1.989688	0.0586
C(26)	0.041264	0.274747	0.150191	0.8819
C(27)	-5.165204	3.187042	-1.620689	0.1187
C(28)	0.348375	0.210722	1.653247	0.1119
C(29)	-0.218472	0.329787	-0.662463	0.5143
C(30)	0.251249	0.190437	1.319323	0.2000
C(31)	-0.042023	0.114666	-0.366480	0.7174
C(32)	-0.029437	0.016081	-1.830514	0.0802

R-squared	0.232690	Mean dependent var	-0.021212
Adjusted R-squared	-0.000839	S.D. dependent var	0.056460
S.E. of regression	0.056483	Akaike info criterion	-2.692100
Sum squared resid	0.073379	Schwarz criterion	-2.322039
Log likelihood	49.72756	Hannan-Quinn criter.	-2.571470
F-statistic	0.996407	Durbin-Watson stat	1.852625
Prob(F-statistic)	0.458613		

Dependent Variable: D(LNFINC_DEV_CAPITA)
Method: Least Squares

Date: 04/15/16 Time: 12:25
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
D(LNFINC_DEV_CAPITA) = C(33)*(LNCO2_KT__CAPITA(-1) - 10.6801254867*LNGDP__CAPITA__CURRENT_(-1) + 0.710436553367*LNGDP_SQUARED(-1) - 0.147727992789 *LNENERGY__CONS_CAPITA(-1) + 0.17696470122 *LNFINC_DEV_CAPITA(-1) - 0.307477706315*LNTRADE_CAPITA(-1) + 44.6558674507) + C(34)*D(LNCO2_KT__CAPITA(-1)) + C(35) *D(LNGDP__CAPITA__CURRENT_(-1)) + C(36)*D(LNGDP_SQUARE D(-1)) + C(37)*D(LNENERGY__CONS_CAPITA(-1)) + C(38) *D(LNFINC_DEV_CAPITA(-1)) + C(39)*D(LNTRADE_CAPITA(-1)) + C(40)

	Coefficient	Std. Error	t-Statistic	Prob.
C(33)	0.030871	0.085490	0.361112	0.7213
C(34)	-0.067720	0.240400	-0.281696	0.7807
C(35)	5.416128	2.788625	1.942222	0.0645
C(36)	-0.351515	0.184379	-1.906479	0.0692
C(37)	0.416307	0.288560	1.442705	0.1626
C(38)	0.264179	0.166631	1.585416	0.1265
C(39)	0.013101	0.100332	0.130578	0.8972
C(40)	-0.000916	0.014071	-0.065105	0.9487

R-squared	0.500455	Mean dependent var	-0.019377
Adjusted R-squared	0.348420	S.D. dependent var	0.061227
S.E. of regression	0.049422	Akaike info criterion	-2.959189
Sum squared resid	0.056179	Schwarz criterion	-2.589128
Log likelihood	53.86743	Hannan-Quinn criter.	-2.838559
F-statistic	3.291706	Durbin-Watson stat	1.977296
Prob(F-statistic)	0.014187		

Dependent Variable: D(LNTRADE_CAPITA)
Method: Least Squares
Date: 04/15/16 Time: 12:26
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
D(LNTRADE_CAPITA) = C(41)*(LNCO2_KT__CAPITA(-1) - 10.6801254867 *LNGDP__CAPITA__CURRENT_(-1) + 0.710436553367 *LNGDP_SQUARED(-1) - 0.147727992789*LNENERGY__CONS_CAP ITA(-1) + 0.17696470122*LNFINC_DEV_CAPITA(-1) - 0.307477706315 *LNTRADE_CAPITA(-1) + 44.6558674507) + C(42) *D(LNCO2_KT__CAPITA(-1)) + C(43)*D(LNGDP__CAPITA__CURREN T_(-1)) + C(44)*D(LNGDP_SQUARED(-1)) + C(45) *D(LNENERGY__CONS_CAPITA(-1)) + C(46)*D(LNFINC_DEV_CAPIT A(-1)) + C(47)*D(LNTRADE_CAPITA(-1)) + C(48)

	Coefficient	Std. Error	t-Statistic	Prob.

C(41)	0.381134	0.195849	1.946058	0.0640
C(42)	-0.390841	0.550736	-0.709671	0.4850
C(43)	3.747812	6.388496	0.586650	0.5632
C(44)	-0.240525	0.422397	-0.569428	0.5746
C(45)	0.687086	0.661066	1.039362	0.3094
C(46)	0.307705	0.381736	0.806066	0.4285
C(47)	-0.167196	0.229851	-0.727410	0.4743
C(48)	0.052239	0.032235	1.620571	0.1187

R-squared	0.181849	Mean dependent var	0.024722
Adjusted R-squared	-0.067154	S.D. dependent var	0.109602
S.E. of regression	0.113222	Akaike info criterion	-1.301289
Sum squared resid	0.294844	Schwarz criterion	-0.931228
Log likelihood	28.16998	Hannan-Quinn criter.	-1.180658
F-statistic	0.730308	Durbin-Watson stat	2.124491
Prob(F-statistic)	0.648388		

Table 7: Short run Granger causality results

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.756909	(6, 22)	0.0375
Chi-square	16.54145	6	0.0111

Null Hypothesis: C(2)=C(3)=C(4)=C(5)=C(6)=C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	-0.285026	0.265230
C(3)	-4.502545	2.995926
C(4)	0.304597	0.198020
C(5)	-0.185887	0.311736
C(6)	0.124236	0.181257
C(7)	-0.137596	0.107358

Restrictions are linear in coefficients.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.306981	(5, 23)	0.9037
Chi-square	1.534903	5	0.9090

Null Hypothesis: C(10)=C(11)=C(12)=C(13)=C(14)=C(15)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(10) - C(15)	0.212244	0.596677
C(11) - C(15)	-6.570992	6.544090
C(12) - C(15)	0.591469	0.519628
C(13) - C(15)	0.056865	0.782013
C(14) - C(15)	0.322860	0.479346

Restrictions are linear in coefficients.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.749114	(6, 23)	0.6163
Chi-square	4.494684	6	0.6100

Null Hypothesis: C(18)=C(19)=C(20)=C(21)=C(22)=C(23)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(18)	1.330279	8.547772
C(19)	-106.6809	99.15357
C(20)	7.444798	6.555869
C(21)	-0.606514	10.26017
C(22)	3.188689	5.924791
C(23)	-1.811426	3.567440

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.881914	(6, 23)	0.5237
Chi-square	5.291481	6	0.5070

Null Hypothesis: C(26)=C(27)=C(28)=C(29)=C(30)=C(31)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(26)	0.041264	0.274747
C(27)	-5.165204	3.187042
C(28)	0.348375	0.210722
C(29)	-0.218472	0.329787
C(30)	0.251249	0.190437
C(31)	-0.042023	0.114666

Restrictions are linear in coefficients.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.058158	(6, 23)	0.0238
Chi-square	18.34895	6	0.0054

Null Hypothesis: C(34)=C(35)=C(36)=C(37)=C(38)=C(39)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(34)	-0.067720	0.240400
C(35)	5.416128	2.788625
C(36)	-0.351515	0.184379
C(37)	0.416307	0.288560
C(38)	0.264179	0.166631
C(39)	0.013101	0.100332

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.451728	(6, 23)	0.8363
Chi-square	2.710369	6	0.8442

Null Hypothesis: C(42)=C(43)=C(44)=C(45)=C(46)=C(47)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(42)	-0.390841	0.550736
C(43)	3.747812	6.388496
C(44)	-0.240525	0.422397
C(45)	0.687086	0.661066
C(46)	0.307705	0.381736
C(47)	-0.167196	0.229851

Restrictions are linear in coefficients.