RELATIONSHIP BETWEEN RENEWABLE ENERGY, ECONOMIC GROWTH AND CARBON DIOXIDE (CO2) IN MALAYSIA

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DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

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DEDICATION

We would like to dedicate this thesis to our supervisor, Dr. Abdelhak Senadjki for his suggestions, encouragement and help to coordinate our research project especially in writing.

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LIST OF ABBREVIATION

ADF	Augmented- Dickey Fuller
AGR	Agriculture
ARCH	Autoregressive Conditional Heteroscedasticity
ARDL	Autoregressive Distributed Lag
ASEAN	Association Southeast Asian Nations
CO_2	Carbon Dioxide
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Recursive Residuals of Square
DEA	Data Envelopment Analysis
ECM	Error Correction Model
ECT	Error Correction Term
EKC	Environment Kuznets Curve
GDP	Gross Domestic Product
JB	Jarque- Bera
LM	Lagrange Multiplier
MAN	Manufacturing
OLS	Ordinary Least Square

RE	Renewable Energy
SER	Services
UECM	Unrestricted Error Correction Model
VAR	Vector Autoregressive
VEC	Vector Error Correction
VECM	Vector Error Correction Model

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PREFACE

This research project is submitted in partial fulfillment of the requirement for the degree of Bachelor of Business Administration (HONS) Banking and Finance at University Tunku Abdul Rahman (UTAR). This research paper is conducted under the supervision of Dr. AbdelhakSenadjki. This study provides a detailed explanation of our topic we completed towards accomplishing our project goals.

The title for this report is "The relationship between Renewable Energy, Economic Growth, and Carbon Dioxide (CO_2) in Malaysia". The variables which include Renewable Energy, GDP per sectors (Agriculture, manufacturing, and services) and Carbon Dioxide (CO_2). Objectives of this research are to investigate the relationship between renewable energy, GDP by sector and carbon dioxide and also examine the relationship between GDP by sector and carbon dioxide in Malaysia for the period from year 1990 to year 2011.

Firstly, this study begins by introducing the topic selected and explaining the relationship between each of the variables. This study provides the explanation of the four main hypotheses that was followed in order to achieve the goals. This study then examines the relationship between each of the variables according to the objectives in detailed literature review. Next, data description and econometric techniques are presented to achieve the study's goals. The result of diagnostic checking and the existence of long run relationship between GDP per sectors, renewable energy and carbon dioxide (CO_2) are provided.In conclusion, this research paper concluded the overall test results, policy implications, limitations and recommendations.

ABSTRACT

This study aims to investigate the relationship between renewable energy, carbon dioxide (CO_2) and gross domestic product (GDP) by sector in agriculture, manufacturing and services in Malaysia from year 1990 to 2011. This study has a sample size of 22 years. Autoregressive Distributed Lag (ARDL) approach was applied to investigate the short run and long run causal relationship between renewable energy, $CO_2$and GDP by sector. The result showed that there is unidirectional causal relationship running from renewable energy to GDP in long run and unidirectional causal relationship running from GDP to renewable energy in short run. Besides that, this study has found that there is positive bidirectional causal relationship between $CO_2$and GDP in long run and short run. For GDP in agriculture and renewable energy, the results shows there is positive bidirectional relationship between GDP in agriculture and renewable energy in long run, but unidirectional causal relationship running from renewable energy to GDP in agriculture in short run. Furthermore, the results show that there is unidirectional causal relationship running from CO_2 to GDP in agriculture in long run, but no causal relationship between CO_2 and GDP in agriculture. For GDP in manufacturing and renewable energy, the result shows that both are not co-integrated in long run and short run. Moreover, this study shows that there is unidirectional causal relationship running from GDP in manufacturing to CO_2 in long run, but no causal relationship in short run. For GDP in services and renewable energy, the results show that there is positive bidirectional causal relationship in long run but no causal relationship in the short run. In addition, this study shows that there is no causal relationship between GDP in services and CO_2 in long run and short run. Lastly, this study provides useful information for

government, policy maker, and public investors to regulate economic and environment more effectively.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

Energy is considered as the vital of an economy and also the most important instrument of economic development and the vital strategic commodities as well (Sahir & Qureshi, 2007). Energy is not only necessary for the economy but its supply is uncertain (Zaleski, 2001). Energy included fuel, power, light which usually used in the industrial process, agriculture, mining, and services which included transport and information technology sectors. Consequently, when agricultural and industrial activities increase, the demand for energy consumption increases as well. Thence, the part of energy cannot be denied in this modern era (Azam, Khan, Bakhtyar & Emirullah, 2015).

Recently, scientists looking for new sources such as renewable energy to substitute oil-based fuels as the high demand for energy are the major cause of environment pollution. The use of fossil energy is the basic engine for economic growth and also the main cause of the emissions of carbon dioxide. The rapidly increase of global warming is caused by the carbon dioxide emissions. Many studies have concerned on the economic growth if limiting the future emissions of the carbon dioxide. The growth of economic will be affected since the carbon dioxide emission and fossil fuel energy consumption are closely related (Ramanathan, 2005).

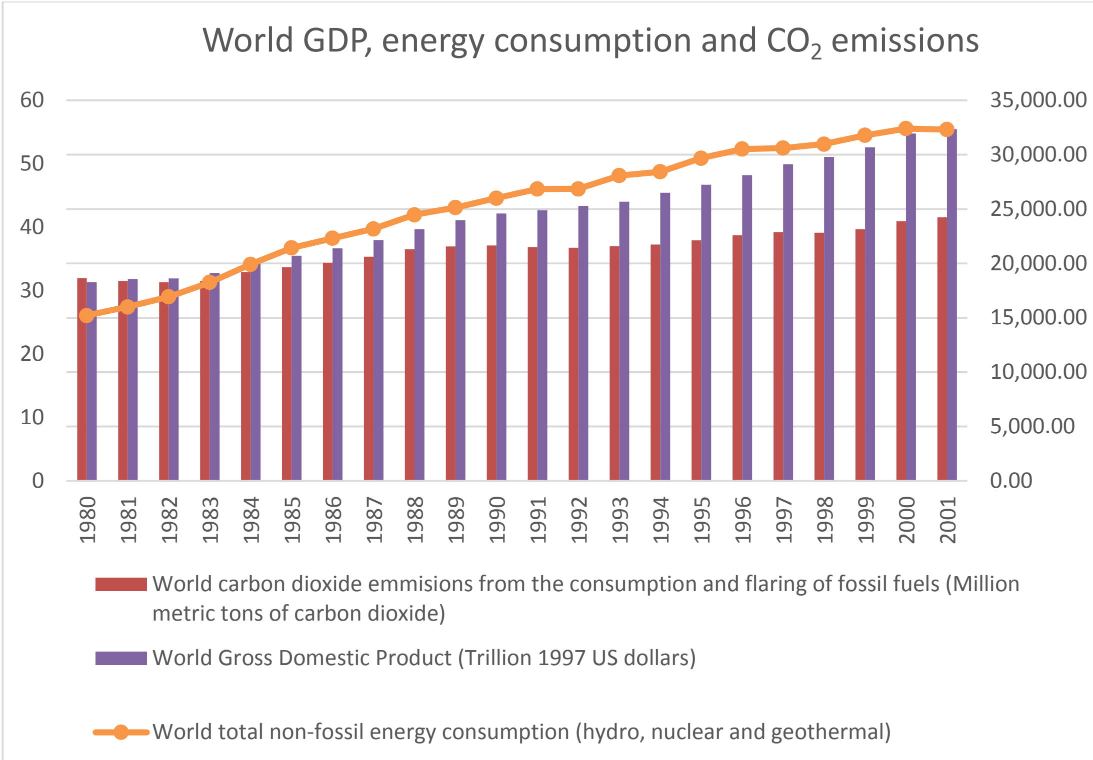


Figure 1.1 shows the world GDP, energy consumption and CO_2 emissions for the period 1980-2001.

Source: IEA (2004)

From figure 1.1, the amount of world carbon dioxide emission from the consumption of fossil fuels, world gross domestic product and also the world total non-fossil energy consumption increases from year 1980 until the year 2001. The world carbon dioxide emission from the consumption of fossil fuels hit the lowest amount in 1982 with 18,264.31 (million metric tons of carbon dioxide) where it reached the highest in 2001 with 24,228.08. The world GDP reached the lowest amount of 18,245.64 (trillion 1997 US dollars) in 1980. It rose for the following year and hit the highest amount 32,354.43 in 2001. The world total non-fossil energy consumption increases as well. The lowest amount was in 1980 with 26.08 where the highest is 55.55 in 2000. After the peak amount in 2000, it slightly decreased to 55.40 in 2001. The increase of the CO_2 emissions caused the climate change nowadays which is the main on-going concern of both the developing countries and developed countries. The rapid economic growth of the developed countries led to the intensive use of energy. This causes even more residues and wastes that are throwing to the nature that lead to more degradation of the environment. The greenhouses effect in the recent years has caught a great attention which causes CO_2 emissions. The consumption of fossil fuel which produces the CO_2 such as coal is the main source of automobile industry that closely related with economic growth and development. These are the reason why the rate of GDP, CO_2 emissions and energy consumptions increase year by year (Saidi & Hammami, 2014).

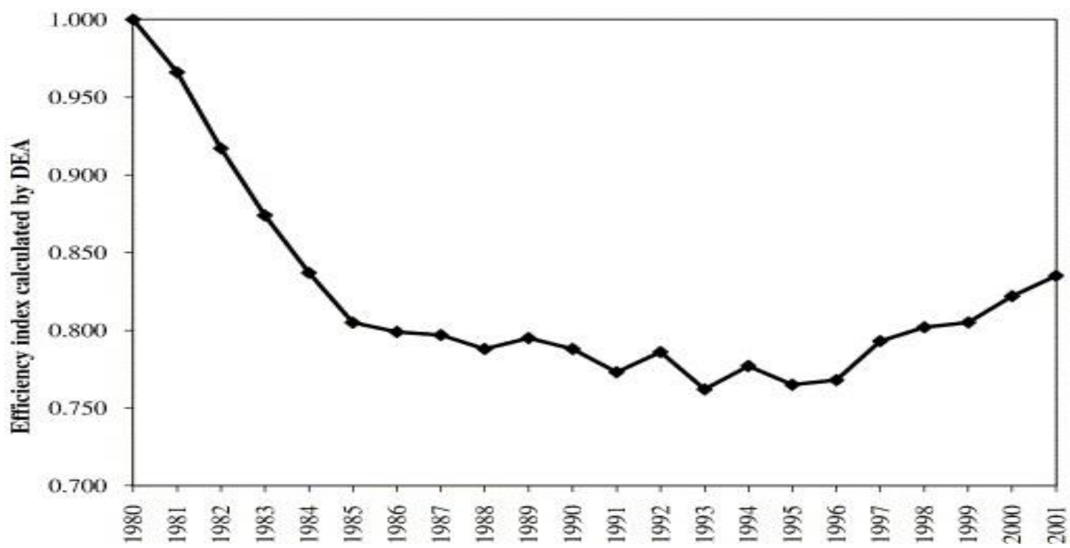


Figure 1.2 shows the patterns of production and consumption efficiency index calculated by DEA for the period 1980-2001.

Source: Ramanathan (2005)

Data Envelopment Analysis (DEA) combines the GDP growth, CO_2 emissions and energy consumption of the world in different years. It used to forecast the linkages between energy consumption, CO_2 emissions and economic growth. In 1980, the efficiency was the highest among the years, which means the world produced more GDP and less carbon dioxide given the energy consumed in this year if compared to other year. In 1980, there may be due to the relatively lesser consumption of fossil fuel and cause the lesser emissions of carbon dioxide. It continuingly decreases over the next few years until the year 1988. The slightly increase of the efficiency index shows that the fossil fuel consumption increases in this year. Moreover, it started to fluctuate with a dropping trend for the next seven years, before beginning an upward trend from 1996 to 2001. The upward movement of the efficiency index reflects the awareness of the world community to improve the efficiencies in production and consumption of energy (Ramanathan, 2005).

Bartleet and Gounder (2010) confirmed the existence of the co-integrated relationship between economic growth, employment and energy consumption. The economic growth causes the energy consumption and economic activity lead to the increase in demand of energy which shown by the causality results. Shyamal and Rabindra (2004) found that the CO_2 emissions in industrial sector showed a dropping trend after improving the energy efficiency and fuel switching but in agricultural sector, there was nearly insignificant effect of pollution and energy intensity on CO_2 emissions. Besides, Apergis and Payne (2010) found that there is granger causality relationship running from energy consumption and economic growth to CO_2 emissions. The results also showed the bidirectional relationship between energy consumption, CO_2 emissions and economic growth. Fodha and Zaghdoud (2010) showed that the Environment Kuznets Curve (EKC) literature studied the presence of a statistically significant correlation among the economic activity level and also environmental degradation. A unidirectional causal relationship was implied when the degradation of the environment represent the dependent variable.

As a developing country, Malaysia is trying to improve its economic growth to become a high income nation by year 2020. To sustain the economic growth, more energy is needed to support its GDP. Currently, the main electricity generated in Malaysia is depends on fossil fuels and natural gas (Ashnani, Johari, Hashim & Hasani, 2014). In term of long run, the electricity supply is not a secure option. Therefore, the government of Malaysia had come out with several energy policies to substitute the energy supply to renewable energy (RE).

Table1.1 Energy policy in Malaysia

Policy name and year	Description of energy policy
Petroleum Development Act 1974	Vested the exclusive right to explore, develop and produce petroleum in Malaysia to PETRONAS
National Petroleum Policy 1975	Regulate downstream oil and gas industry via Petroleum Act
National Energy Policy 1979	Objectives : Supply, Environmental and Utilization
National Depletion Policy 1980	Prolong lifespan of Malaysia's oil reserves for the future
Four-Fuel Diversification Strategy 1981	Balance utilization of hydro, coal ,oil and gas
Five-Fuel Diversification Strategy 2001	RE included as fifth fuel in energy mix
National Biofuel Policy 2006	Promote demand for palm oil
National Renewable Energy Policy and Action Plan 2010	Enhance the utilization of indigenous renewable energy resources

Table 1.1 shows the energy policies that implemented in Malaysia. The objectives are to target the utilization of RE sources. In five-fuel diversification, RE energy is added as the fifth source of fuel to energy mix, namely oil, natural gas, coal, hydro power and renewable energy. The aim is to produce 5% of the country's electricity power from renewable sources by 2005. In National Renewable Energy Policy and Action Plan 2010, the goals are to increase the contribution of renewable energy to electricity power generation mix and to help to growth the RE industry. The government is trying to make the RE available at reasonable cost and increase awareness of the public on the importance of renewable energy (Razak, 2010). In year 2015, renewable energy production reached 5.5% in Malaysia's power mix (Mancheva, 2015).

By using renewable energy, it can contribute to a sustainable electricity generation system with less emission of CO_2 and support the constant growth of GDP in Malaysia. In Malaysia's 8th policy plan (2001-2005), 5% of the total energy generated by Malaysia is allocated for RE. In the plan mentioned including biogas, biomass, solar, wind and hydropower. But it only applied hydroelectric, solar system, biomass and biogas since Malaysia is a region humid climate which can easily access to different kind of RE sources. Wind energy is not applicable.

Table 1.2 shows the different types of energies Malaysia used in 9th Malaysia Plan

Energy	**Share (%)**
Natural gas	56
Coal	36
Hydropower	6
Oil	0.2
Renewable Energies	1.8

Source: Bakhtyar, Zaharim, Asim, Sopian and Lim. (2012)

Malaysia targeted renewable energy capacity to be connected to power utility grid and power generation mix. The 9th Malaysia plan also included to reduce carbon intensity by 40% lower than 2005 levels by year 2020. Under 10th Malaysia plan (2011-2015), government undertake a more strategic development of energy supply by diversify the energy resources which included renewable energy resource. They will be in considered as source of energy (Razak, 2010).

Due to rapid economic growth, CO_2 emissions in Malaysia have increase dramatically since year 1990 (Bakhtyar et al., 2012). Fossil fuels contribute most of the total CO_2 increment. The increment of CO_2 will increase greenhouse gas (GHG) which causes greenhouse effect. As GDP increase, CO_2 emission will increase continuously. By implementing RE to produce energy for economic growth, Malaysia can continue to have a stable grow of GDP with lower CO_2 emission which cause less harmful to the environment. This study focuses on GDP by sector which is agriculture, manufacturing and services in Malaysia. Service is the largest contributor to the Malaysia GDP which is 56%, manufacturing contribute 34.7% and agriculture contribute 9.3% (The World Factbook, 2015). As the biggest contributor to GDP in Malaysia, services sector in Malaysia mainly distribute into Finance and Banking service, wholesale and retail trade, transportation, storage and communications. Manufacturing sector mainly divided into electronic industry, automotive industry and construction industry. Whereas agriculture sector manly produce paddy, coconut, palm oil and rubber.

Solar is a key role in Malaysian future renewable energy plans. Carbon dioxide produces by conventional electricity generation is harmful to the atmosphere. It may cause the global warming and greenhouse effect. Other chemical such as Sulphur dioxide and nitrogen dioxide will also be produced, depends on the type of method of burning. Renewable energy plays an important role in economy to make the world a better way (Ashnani et al., 2014).

The Malaysian government has tried examining and searching for other possible renewable energy sources. The renewable energy will help to save cost compare to the cost of energy generated from fossil fuel. The increase of the supply of renewable energy can help to reduce global warning emissions and to replace carbon-intensive energy sources. Carbon dioxide may cause air and water pollution that can affect human health (Ashnani et al., 2014).

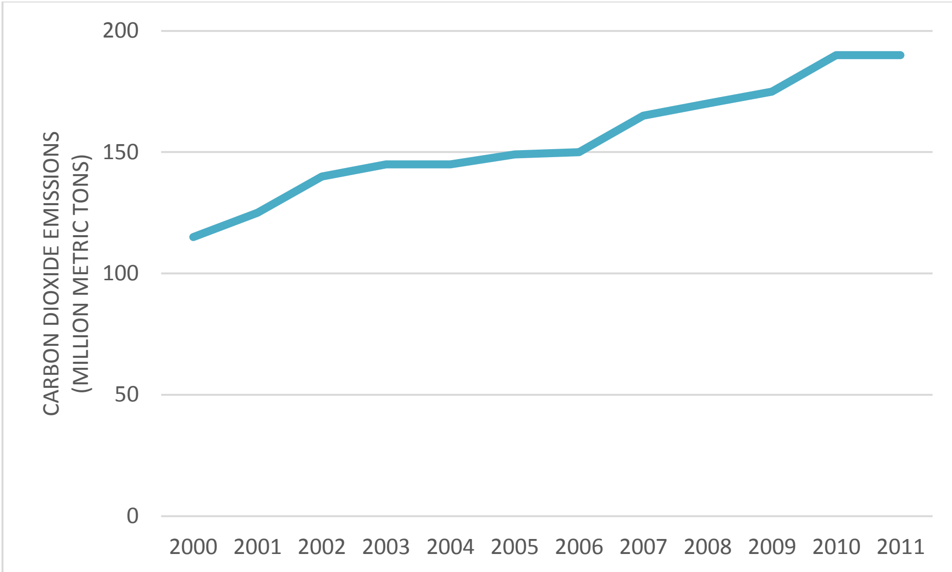


Figure 1.3 shows total carbon dioxide emissions from fossil fuel in Malaysia

Source: Ashnani et al. (2014)

Figure1.3 shows that the carbon dioxide emissions from fossil fuels in Malaysia increase significantly from year 2000 to 2011. Switching from high-carbon fuels like coal, oil and natural gas to renewable energy can help to reduce carbon dioxide emissions. The atmosphere is overloading with carbon dioxide and other global warming emissions. It will trap heat, the increases of earth's temperature, and harm our environment and health (Union of Concerned Scientists, 2015).

In every year, around 30 billion tons of CO_2 enter into atmosphere as results from human immoral activity such as, burning fuel. The reason Malaysia's economy structure boost up is mainly from speed transformation from agriculture production to more resources in heavy manufacturing. Resulting in increased population will lead to increase in concentration of CO_2 emission (Saboori, Sulaiman & Mohd, 2012). Carbon dioxide emission in Malaysia was 7.32 metric ton per capita as compare with average the world was 4.63. Thus, result show that Malaysia has release the most CO_2 into atmosphere. Environment Kuznet Curve shows that CO_2 and GDP have closely relationship and have long run relationship between environment impact and economic expansion.

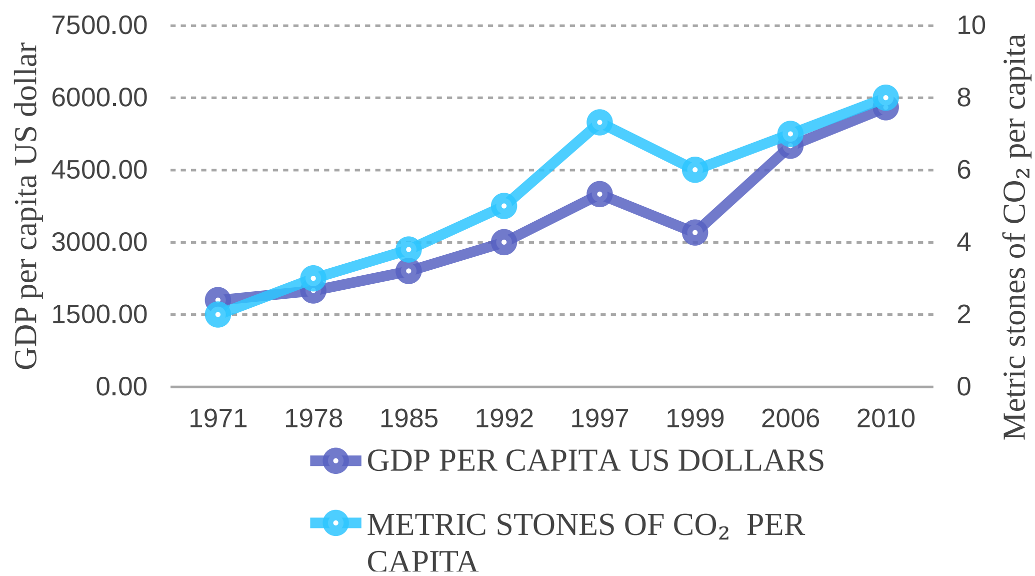


Figure 1.4 shows Malaysian CO_2 per capita and GDP per capita for the 1970-2010 periods

Source: Bekhet&Yasmin (2013)

Malaysia has recorded annually growth rate of CO_2 emission from year 1971 to 2010. The graph showed that there is slowly an increase in CO_2 emissions metric tons per capital from year 1971 to 2006. But in between year 1992 to 1999 it shows that Malaysia was around 7.32 metric tons per capita while the GDP was in 4000 per capita USD. After few years, CO_2 emissions have been reduced to around 4 metric tons per capita. From year 2001 to 2010 the number of CO_2 emission fluctuating at the same time when reaching 2010, the number of CO_2 has not been reached to maximum level which was around 8 metric tons per capita while the GDP is 6000 per capita USD. Thus, they are closely link together. When GPD increases, CO_2 emissions will increases as well. Government in Malaysia had implemented environmental policy which is national green technology to reduce CO_2 emission into atmosphere and maintain the Malaysia GDP. Although government have implemented the environment policy, from the graph it shows that there is an increaseinCO$_2$ emission, in other words, government do not strictly take action against the CO_2 emission (UNFCCC, 2009).

In year 2009, Malaysia has been achieved a stable GDP growth of 4.6% among the Association of Southeast Asian (ASEAN) countries (IMF, 2010). Energy is an important requirement for economic growth and also a controlling factor to social development, economic and also the quality of life. In Malaysia fossil fuel is the main resource to generated electricity, but it will eventually running out in the future (Sulaiman, Azman & Saboori, 2013).

From year 1970 to 1980, Malaysia's economic is transformed form primary sector (Agricultural) to secondary sector (Industrial). Recently, Malaysia is slowly developing the services sector which is highly consuming energy. There is significant link between renewable energy consumption and economic growth in Malaysia. At the same time, there are various factors that affect the GDP change, thus to the best of this study's knowledge, there is no studies of the transmission mechanism between GDP by sector and renewable energy in Malaysia.

Bekhet and Yasmin (2013) found that Malaysia government pays more attention to renewable energy because of the shrinking of fossil fuels driving with oil prices increase and global warning. By using renewable energy such as biodiesel to replace fossil fuel can maintain the green environment. Reduction of fossil fuel can help to decreases the carbon dioxide emission which can decelerate pollution. By using palm oil biodiesel to substitute fossil fuel in order to generate the clean energy can lead to CO2 emissions. The price of the palm oil biodiesel is much cheaper compare to fossil fuel and palm oil. Sadorsky (2009) estimated the relationship between GDP and renewable energy consumption per capital for 18 emerging economies which including Malaysia. Sadorsky (2009) showed that GDP growth leads to renewable energy consumption increasing as well. Hence, there is positive link between the GDP and renewable energy consumption. Menegaki (2011) analyzed that in the year of 1997- 2007 there is 27 European countries using the random effect model to estimate that there is the causal relationship between the GDP and renewable energy consumption. In previous study, it's been showed that economic growth and carbon dioxide have long run relationship between each other. A high GDP will result in higher emission of carbon dioxide and this will cause air pollution (Saboori et al., 2012). Next, the increases in energy consumption will increase in GDP. Thus, lead to increase carbon dioxide emission into atmosphere. Fodhaand Zaghdoud (2010) showed that Malaysia economy do not exist the Environmental Kuznet Curve (EKC) hypothesis.

Some of the researchers study on EKC hypothesis used cross sectional data to analyses the developing country which is to establish the link between GDP and environmental degradation (carbon dioxide emission). Saboori et al.(2012) provides general knowledge of how carbon dioxide and GDP are related. Malaysia lacks of common EKC hypotheses to estimate accurate carbon dioxide emission release to atmosphere by sector. The estimation of carbon dioxide emission in Malaysia was reported in whole country, Malaysia do not classify and estimate the carbon dioxide into sector because in agriculture, manufacturing and services do not use EKC (Saboori et al., 2012). Another the limitation is climate change, the country could not predict the exactly amount of carbon dioxide emission by sector into atmosphere (Bekhet & Yasmin, 2013).

1.1Problem Statement

In Malaysia, the relationship between renewable energy, CO_2 and GDP are widely studied. Due to rapid development in Malaysia, the industry is moving at a faster pace. The government realized that more power utility grid is needed to support the growth of the Malaysia's industry. However problem rises where the more energy produced lead to higher carbon dioxide emission. Although Malaysia's GDP is increasing every year, but due to high amount of energy produced, the amount of carbon dioxide release could cause greenhouse effect. To solve the problem, Malaysia's government started to implement renewable energy to connect to power utility grid. Renewable energy which is environmental friendly can help to generate more energy needed and reduce carbon dioxide emission. Malaysia's government plans to reduce carbon intensity by 40% lower by year 2020 with the help of renewable energy as the carbon dioxide emission in Malaysia was 7.9 metric ton per capital in year 2011 (WorldBank, 2011). Although renewable energy is still not the main energy contribution in Malaysia, the government is slowly substituting fossil fuel and natural gas to solar and hydroelectric as they generate large amount of energy which can be store for long term usage. While focusing on renewable energy, using a substituted energy from the main energy source would probably cause other conflict with the industry itself. As GDP in Malaysia is contributed by 3 major sectors which are agriculture, manufacturing and services.

In order to sustain the energy production while increasing GDP growth and reduce carbon dioxide emission, renewable energy acts as an important role in the long run industry contributor. To have a better understanding and more significant results, the study focuses on the relationship of renewable energy with carbon dioxide emission and the relationship of renewable energy with GDP by sectors in term of agriculture, manufacturing and service. The results of the study should be profitable to the policy maker where using renewable energy could help to generate more energy needed and have a health GDP growth in the long run.

1.2Research Question

- How does renewable energy affect GDP by sector and carbon dioxide?
- What is the effect of GDP by sector toward carbon dioxide?

1.3Research Objectives

- To investigate the relationship between renewable energy, GDP by sector and carbon dioxide.
- To examine the relationship between GDP by sector and carbon dioxide.

1.4Significant of study

This study investigates the relationship between renewable energy, carbon dioxide and gross domestic product (GDP) by sectors in agriculture, manufacturing and services. The study will extend the understanding of the relationship between renewable energy and GDP by sector, the relationship between carbon dioxide emission and GDP by sector. Each sector will have different impact on the implication of renewable energy as well as emission of carbon dioxide. By narrowing down GDP by sector, the research study would be very useful to the policy maker and community in order to sustain the environment with a constant economic growth.

1.5Conclusion

The objective of this research is to investigate the relationship between renewable energy, carbon dioxide, and GDP by three sectors (Agriculture, Services, and Manufacturing) in Malaysia. This study provides important information to both government and investor to have more knowledge about the renewable energy.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The relationship between GDP and energy consumption is significant to design an effective energy and environmental policy which will facilitate sustainable development. GDP growth may be affected due to the inefficient usage of energy and it leads to global warming and climate change (Menegaki, 2014). Apergis and Payne (2010) provided an enlightening account on the relationship between energy and GDP growth. Depending on its aims and objectives, how the policy may respond under the four main hypotheses.

2.1 Proposed theoretical / conceptual framework

2.1.1Growth hypothesis

Growth hypothesis referred to the unidirectional causality relation running from energy consumption to GDP. It suggests that energy consumption closely related with GDP growth as the economy is dependent on energy to grow. Energy consumption not only leads the economic growth but it affects it directly and indirectly as a complement to other input factors of production. Energy is an essential factor to economic growth, therefore reductions in the use of energy may cause decrease of economic growth while the increases in energy may cause the economic growth to increase (Caraini, Lungu & Dascalu, 2015). Besides, the increase in energy consumption may negatively affect economic growth. For example, if the economic growth shift to the less energy intensive production such as services sector. The less dependent on energy consumption, the economic growth able to increase and CO_2 emissions may reduce as well. The negative relationship between energy consumption and GDP may be attributed to either overuse of energy in unproductive industries or an inefficient energy supply (Kulionis, 2013). A unidirectional causal relationship from energy consumption to GDP growth reflects an unsustainable energy security situation even high energy resources present in one country. Majority of studies taken place recently concern developed countries (Esso, 2010). Caraiani, Lungu and Dascalu (2015) showed the growth hypothesis was retained specifically for causality between energy and GDP growth in long run. Soytas and Sari (2003) found that the causality between GDP and energy consumption from 1950 to 1992 in the top 10 emerging countries (exclude China) and the G7 countries by using co-integration and vector error correction (VEC) technique, the results confirmed the growth hypothesis for Turkey, France and West Germany.

2.1.2 Conservative hypothesis

Conservative hypothesis implies that GDP growth causes energy consumption where they are unidirectional causality relationship. An economy that functions in such a causal relationship is less energy dependent, thence any conservative policies which concerning energy consumption may have less or no adverse impact on economic growth where an increase in economy may causes an increase in energy consumption (Ozturk, 2010). Energy consumption may decrease without necessarily a negative impact in GDP growth, in this situation, without detriment to GDP growth, the greenhouse reduction measures can be pursued as causal relationship does not run from energy consumption to GDP growth (Menegaki, 2014). Normally short term elasticity was explained by conservation and neutrality hypothesis. The results may differ depending on the countries selected in the investigated panel and on econometric tests conducted by the researchers (Caraiani, Lungu & Dascalu, 2015). Soytas and Sari (2003) confirmed the conservation hypothesis for Italy by using the co-integration and vector error correction (VEC) technique which investigate the causality between GDP and energy consumption from 1950 to 1992 in the top 10 emerging countries (exclude China) and the G7 countries.

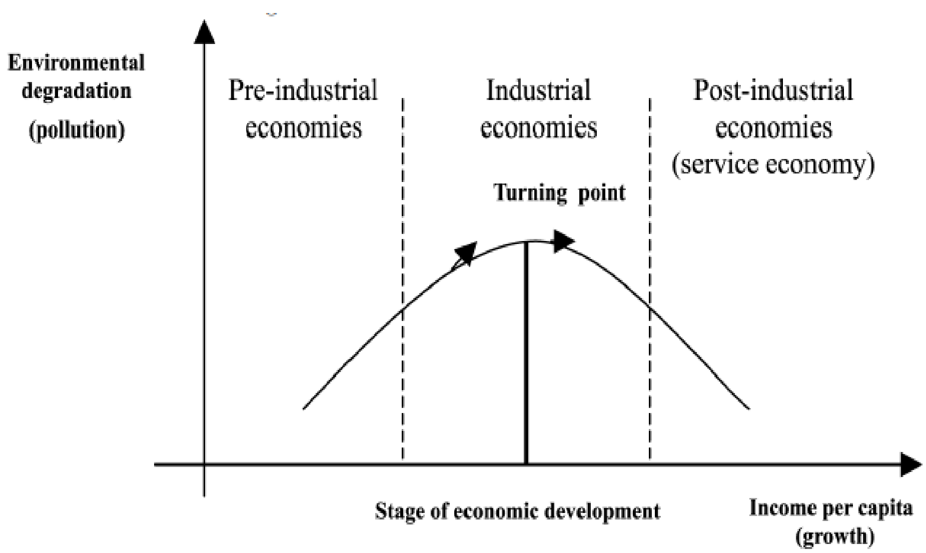
2.1.3 Feedback hypothesis

Feedback hypothesis implies that causality between energy consumption and GDP are closely related as there is bi-directional causal relationship and complements to each other as well. Energy consumption and economic growth are affecting to each other at same time. For example, when energy consumption increases, the GDP increases as well or in the other way round, when increases in GDP, the energy consumption may increases at the same time (Kalimeris, Richardson & Bithas, 2014). The policy implications of the feedback hypothesis are similar to growth hypothesis, the energy conservation measures will eventually decrease growth (Menegaki, 2014). Apergis and Payne (2010) found that there is bidirectional causal relationship between electricity consumption and economic growth for long run and short run in the high income and upper middle income country panels. In addition, Shiu and Lam (2004), Yuan, Kang, Zhao and Hu (2008) and Zou and Chau (2006) stated that, the most frequently used models which is VAR and VECM based on which Granger causality test, few integration and co-integration tests has been used to test the long and short run relationship between energy and income. The national total energy use and coal consumption do not affect GDP growth, while bidirectional causal relationship running from electricity and oil consumption to GDP growth. By using Wald test, Oh & Lee (2004) found that there is bidirectional long run causality between energy and GDP. Masih and Masih (1996) showed energy consumption is causality to income in India, income is causality to energy consumption in Indonesia and bidirectional causal relationship exist in Pakistan by using VECM model. Co-integration and error correction models (ECMs) indicated bidirectional causal relationship between energy consumption and GDP growth for South Korea and Singapore (Glasure & Lee, 1997). Yang (2000) stated that there is bidirectional causal relationship between energy use and GDP in Taiwan. Asafu-Adjaye (2000) result is consistent with the feedback hypothesis in Thailand and Philippines.

2.1.4 Neutrality hypothesis

Neutrality hypothesis suggests that energy consumption has no significant impact on GDP. There is no causality relation and it follows that energy scarcity and conservative policies in relation to energy use do not affect economic growth. This hypothesis is supported if no evidence found of Granger causality between energy consumption and economic growth (Ozturk, 2010). Ang (2007), Ghosh (2002) and Soytas et al., (2007) stated that if there is no causal relationship between energy and GDP or causality tends to run from GDP to energy, there might be potential for further growth. In this situation, energy scarcity does not apply a severe constraint on prospects for economic growth. The energy used can be adjusted within the limits of energy availability. The total output of the economic process could be turn towards less energy intensive goods and technological advance could decouple economic process from energy constraints. Ozturk and Acaravci (2010) found that there are no causality between energy and GDP growth for Albania, Bulgaria and Romania. Glasure and Lee (1997) revealed that there is no causality for energy consumption and GDP growth in South Korea by using the VAR based Granger causality test. In addition, Aqeel and Butt (2001) investigated that no causal relationship between economic growth and gas consumption in Pakistan. Soytas and Sari (2007) result showed no long run causality between carbon emissions, energy consumption and GDP growth.

2.1.5 Environmental Kuznets Curve (EKC) hypothesis:



Source: Panayotou (1993)

Figure 2.1 Environmental Kuznets Curve

The EKC hypothesis is an inverted U-shaped relationship between different pollutants (energy consumption) and income (economic growth) per capita. For example, the increase in environmental pressure until it reached a certain level as income goes up, then it decline while the economic growth continues (Dinda, 2004). Figure 2.1 shows that, the pollutant per capita and income per capita from the low base rise at the same time until it reached a certain point of income at which growth of the pollutant flattens and reverses. An EKC is used to reveal how a technically specified measurement of environmental quality changes as the fortunes of a country change. From the studies common point, the environmental quality exacerbates during the early stages of economic growth and it improves during the later stages. Meaning that, on early stages of economic development and growth, the environmental pressure increases faster than income and it decelerates relative to GDP growth at higher income levels (Kulionis, 2013). Lise (2006) denied EKC hypothesis and found a linear EKC path. Akbostanci, Turut and Tunc (2009) found that Turkish data is consistent with the EKC hypothesis by using time series and panel data models. From another study Ozturk and Acaravci (2010) also found that there is no causality evidence found from the GDP per capita to carbon emissions per capita. Hill and Magnani (2002), Dinda (2004) and Stern (2004) found that most EKC studies used either panel or cross section data for a group of developed and developing countries to establish a relationship between GDP growth and environmental degradation. Jaunky (2010) found that the co-integration and causality between GDP growth and CO_2 emissions on the basis of the EKC hypothesis for 36 high income countries. The evidence in the case of Greece, Malta, Oman, Portugal and United Kingdom proved the support of the EKC hypothesis. However, Ang (2007) and Iwata, Okada and Samreth (2010) for France, Jalil and Mahmud (2009) for China and Nasir and Rehman (2011) for Pakistan found an inverted U shaped curve between GDP growth and CO_2 emissions.

2.2 Literature Review

2.2.1 GDP and renewable energy

There are several number of studies examined the relationship between GDP and renewable energy. Fang (2011) pointed out that there is a positive relationship between the China GDP and renewable energy When there is 1% increase in renewable energy consumption, there will be 0.12% increase in that country real GDP. Wang, Fang, Wang, Huang and Ma (2015) stressed out that the China economy growth and energy consumption has a positive impact in both short run and long run by using the ARDL model and multivariate co-integration model. Sebri and Ben-Salha (2014), based on ARDL and Grange causality test found that the Brazil GDP is positive related to renewable energy. If the renewable energy increases their consumption, the GDP also increase. As the country income increase it causes the development of renewable energy sector and GDP increase (Blazejczak, Braun, Edler & Schill, 2014). In German, the development of renewable energy leads to positive impact with the economic growth, and estimate the GDP will be 3.1% higher by year 2030 in future by reducing the import fossil fuels, create an opportunities for exporting renewable energy facilities and components, and also investing in renewable energy sources, for example wind power plants and solar photovoltaic modules.

2.2.2 GDP in agriculture and renewable energy

However, there are limited empirical studies that carried out the relationship between agriculture sector GDP and renewable energy.

During the period 1972 - 2005, Mushtaq, Abbas and Ghafour(2007) using Johansen's co-integration approach and Granger causality to investigate the causal relationship between the energy consumption and agriculture GDP in Pakistan. He found that there is a unidirectional causality between the agriculture GDP to oil and from electricity to agriculture GDP. So, when there is an increase in agriculture sector, the oil demand will be increase as well.

Bayrakci and Kocar (2012) examined there is a positive relationship between renewable energy and agriculture GDP. Agriculture activities play an important role in Turkey, and it requires a lot of energy to perform production. In year 2008 - 2009, it shown that the agriculture GDP has been decreased due to current energy sources are originate from fossils and coal, and those natural gas and fuel oil are imported from neighboring countries to use for agriculture activities. It does not only affect the country GDP, it also increase the environmental pollution when they using too much of non-renewable energy source in production. Therefore, Turkey government encourages farmers to use renewable energy to perform their activities in future. Malaysia focuses on agriculture economy as a wealth, which involved fishery, cultivation and livestock. It showed that there is 7.5% of agriculture GDP in Malaysia. The changes in lifestyle of Malaysia people will also lead to the changes in their purchasing power and consumption pattern. Therefore, there would be a positive impact between the energy demand and Malaysia agriculture GDP. The empirical results indicated that the Canadian agriculture sector has better capacity to produce energy from biomass (renewable energy), it also help to reduce GHG emissions from agriculture production. It is a positive impact as when they increasing the use of biomass, it will led to increasing in agriculture GDP production as well (Liu, McConkey, Huffman, Smith, MacGregor, Yemshanov & Kulshreshtha, 2014).

Besides that, using biomass to replace coal for electricity production can save the cost compare to a carbon price, therefore, it encourage the market consumer to use renewable energy to replace non-renewable energy.

2.2.3 GDP in manufacturing and renewable energy

Sari and Soytas (2009) used ARDL model to estimate the United States renewable energy consumption, and found that there is a positive relationship between the industrial production and renewable energy consumption. Bowden and Payne (2009) conduct the Toda-Tamamoto causality tests based on the United States data, and find that the industrial primary energy consumption Granger causes the U.S GDP. In year 1983 - 1984, Bilgili (2015) showed there is a positive correlation between the industrial production and renewable energy consumption. The reason is because that increases the adoption of renewable energy in current and future market, for example power generation, heating and cooling, transportation fuels and rural energy service. Secondly, the renewable market, manufacturing will be started to expending across the developing world. Third, it provides an affordable price for consumers by using the renewable energy compare to fossil fuel. While during year 1989 to 1991, Bilgili (2015) found there is negative relationship between industrial production and renewable energy consumption. In conclusion, the renewable energy consumption has positive impacts on industrial production GDP within the low and high frequencies in the US country.

2.2.4 GDP in services and renewable energy

In Spain, Kallas and Gil (2015) found that there is a negative relationship between renewable energy and transportation sector. It is because, consumer did not consider biodiesel as a clear environmentally energy in the transport sector, and there is lack of biodiesel availability in Spain due to low market share. Malaysia is one of the country that the government subsidy the petroleum. As the gasoline is the energy fuel use in vehicles, Malaysia government tries to discover a new energy fuel to substitute fossil fuel, which the transportation sector is highly dependent on it. Renewable energy sources are abundant in Malaysia, especially in biomass. Therefore, Tye, Lee, Wan Abdullah and Leh (2011) found that there is a positive relationship between the use of biomass and transportation.

There is a negative relationship between renewable energy and GDP in transportation in Pakistan. Although there is relatively low 0.2% to introduce the biogas into transportation as an alternate fuel, but it might help to reduce the import bill of oil and also reduces the carbon emissions in Pakistan.

Katircioglu (2014) indicates that tourism development in Turkey has a positive impact with energy consumption. Increase in energy consumption will leads to increase in tourism GDP.

2.2.5 GDP and carbon dioxide

Saboori, Sulaiman and Mohd (2012) showed the carbon dioxide and GDP have positive relationship. GDP increases will lead carbon dioxide emission increases. The reason is because energy consumption is higher, GDP will definitely increase and carbon dioxide emission will be increases. Energy consumption is positively affecting the carbon dioxide in long run and short run (Ang, 2008; Fodha & Zaghdoud, 2010). The result support by Bekhet and Yasmin (2013) prove that export in GDP is rapidly growing. It will lead to GDP in different sector to consume more fossil fuel in order to increases the production to fulfill customer needs, consequently will affecting the environment pollution.

Factors affecting GDP growth such as trade openness will lead to positive relationship between trade openness and carbon dioxide emission (Antweiler, Copeland & Taylor, 2001; Khalil & Inam, 2006). Menyahand and Wolde-Rufael (2010) proved that country consume nuclear energy to increases the production of GDP and it may stimulates carbon dioxide increases as well. Furthermore, GDP growth increases will attract more Foreign Direct Investment to invest on local business, thus production increase will lead to carbon dioxide emission increases (Kentor & Boswell, 2003; Chen & Huang, 2013). Transformation from agriculture to manufacturing will lead to boost up economic growth in country. Hence, this will increases the carbon dioxide emission into atmosphere. Next is the export increases will lead to GDP growth and increase in carbon dioxide (Schofer & Hironaka, 2005; Jorgenson & Kick 2006).

Ang (2008); Fodha and Zaghdoud (2010); Halicioglu (2009) used ARDL to test the co-integration between GDP and Carbon Dioxide emission. Engle and Granger (1987) use Residual- based approach to examine the relationship between carbon dioxide mitigation and GDP. Maximum likelihood based approach and fully modified OLS procedures to examine the positive relationship between GDP and Carbon Dioxide (Johansen & Juselius, 1990). Next, Baltagi (2000) test the co-integration between carbon dioxide and GDP by using Panel data unit roots test. Unit root test also examine by Levin, Lin and Chu (2002) to evaluate the relationship between GDP and carbon dioxide. Moreover, Halicioglu (2009); Lean and Smyth (2010) used co-integration test to investigate the relationship between carbon dioxide emission and GDP.

2.2.6 GDP in agriculture and carbon dioxide

Morison and Lawlor (1999) stated that the over ground biomass significantly increases will result increases carbon dioxide emission. Wheat yield increases, carbon dioxide concentration will be increases as well (Norby & Lou, 2004). C3 plants are the most common and efficient at photosynthesis in cool and wet climates. Increase C3 will increases in carbon dioxide emission (Amthor, 2001; Fuhrer, 2003). Next, Morison and Lawlor (1999) claimed that agriculture crops have positive relationship between carbon dioxide emissions. Carbon dioxide will increases because of the reason raising productivity of farming system and photosynthetically active ecosystem (Wittwer, 1995) Furthermore, Li and Zheng (2011) found that economic growth will stimulate the rising the agriculture carbon dioxide emission in China.

Gaucher, Costanzo, Afif, Mauffette, Chevrier and Dizengremel (2003) showed there is negative relationship between carbon dioxide emission and the plant. Wild Plant will have no relationship with carbon dioxide concentration. Another plant which is apple tree seedlings will not increases carbon dioxide emission. This is because crop producer have improve their nutrient management which can lower down nitrogen manure in farm land and will lead to lower down carbon dioxide emission. Besides that, farmers also enhance the operating efficiency or rear farming method which farmer will consume less fossil fuel, it consequence reduce the environment pollution. Farmer may also use organic method to operate their farm which will reduce carbon dioxide emission. Batts, Morison, Ellis, Hadley and Wheeler (1997) pointed out that there is insignificant relationship between carbon dioxide emission and wheat yield. Most of the plants show that there is insignificant relationship between carbon dioxide emission and agriculture. Li and Zheng (2011) claimed that structure effect and production effect have close relationship with carbon dioxide emission decreases. Li and Zheng (2011) used LMDI and General Environment Kuznets Curve method to analyze the relationship between carbon dioxide emission and GDP in agriculture

2.2.7 GDP in manufacturing and carbon dioxide

Burke, Shaiduzzaman and Stern (2015) argued that there is positive relationship between carbon dioxide emission and GDP in Manufacturing in OECD country and non-OECD country. Cole (2008) claimed that manufacturing activities is one of the factors that lead to carbon dioxide emission to rise in China. Robert and Grimes (1997); Cole (2008); Zhang, Mu, Ningand Song (2009) there is positive relationship between manufacturing growth and carbon dioxide emission. Yan and Fang (2015) found that carbon dioxide is combustion of fossil fuel have close relationship with manufacturing because industry burning fossil fuel and cause carbon dioxide emission will increases and release into atmosphere and will cause climate change. Zhang (2000) claimed that economic growth can cause Canada emission to increase due to increases size of country’s industry sector. Lin, Moubarak and Ouyang (2014) suggest that there is long run equilibrium relationship between carbon dioxide and industry growth this is because energy increases in order to support industry growth and, thus lead to carbon dioxide emission increases.

Bruke (2010); Liao and Cao (2013) have been conducted there is long run relationship between carbon dioxide and GDP in manufacturing. The reason why the carbon dioxide and GDP in manufacturing have positive relationship is because industry sector develop in term of import and export activities, industry sector need to consume more coal and electricity to produce the product, thus producer need to consume more coal in other words means burning coal and produce mineral product will lead to increases in carbon dioxide increases in China (Zhou, Zhang & Li, 2013). Lin, Moubarak and Ouyang (2014) claimed that the urban developing population size increases, energy consumption will be expand, consequently will lead rapid growth of carbon dioxide emission. When country having transformation, infrastructure will slowly evolution and most of the infrastructure need more fuel consumption this will lead to pollution and degradation to environment (Li Zhao, Liu & Zhao, 2015). Lin and Lei (2015) proven that there is significant relationship between carbon dioxide emission and food industry in China, the reason is that population in China has been expanding and food is an necessity for human, therefore the food industry might need to enlarge their production, this will lead to energy consumption and will result to increase carbon dioxide emission.

Shen, Cheng, Gunson and Wan (2005) stressed that cement industry will bring up the carbon dioxide emission, this is because the cement production is high and require cement clinker to operating, thus the machine is mostly rely on fuel to generate the product, thus the cement have high production this will lead carbon dioxide emission to increase. On the other hand, iron and steel industry is an important sector which polluted environment. Reason is because chemical reaction and combustion of fossil fuel which will affect the environmental (Chontanawat, Wiboonchutikula & Buddhivanich, 2014). Steel industries develop significant increases carbon dioxide emission. Non-metallic mineral product is another factor which will influence the evolution of carbon dioxide emission because nonmetallic mineral production need consume coal and combustion of coal will increase the carbon dioxide emission (Lin & Ouyang, 2014).

Moreover, there is negative relationship between carbon dioxide emission and manufacturing growth. In year 1993, 1994 and 1996 there is structural stability in manufacturing sector and energy diversification in China (Lin, Moubarak & Ouyang, 2014). Another reason is because development countries use nuclear and renewable energy to produce GDP in manufacturing sector. In addition, Burke, Shaiduzzaman and Stern (2015) found that GDP in industry cannot intervene because this can affect the carbon dioxide emission, if they use unsuitable method to intervene the size industry sector will reduce the GDP growth. Third, Hosseini, Wahid and Aghili (1993); Gambhir, Schulz, Napp, Tong, Munuera, FaistandRiahi (2013); Tian, Zhuand Geng (2013) said that the reason energy is used is to develop plan of economic factor which improve the tradition of manufacturing into advance technology. Besides that, consumption structure change and volume, material efficiency improvements are the reason that causes carbon dioxide emission to have negative relationship with GDP in manufacturer. Wang et al. (2015) found that there is inverse relationship between carbon dioxide emission and manufacturing, reason is because manufacturing have low energy efficient, thus energy usage technical efficiency change will contribute the carbon dioxide emission reduce in US country. Moreover developed countries have advance technology which is Carbon Abatement Technology (CATECH) and Energy Saving Technology (ESTECH) can reduce carbon dioxide emission into atmosphere.

Burke, Shaiduzzaman and Stern (2015) used Unit roots test to determine the relationship between carbon dioxide and GDP in manufacturing. Zhou, Zhang and Li (2013) used system Generalized method movement (SYS-GMM) to examine the effect of industries structure change on carbon dioxide emission in China. Besides that, they also use Logarithmic Mean Divisia Indext (LMDI) method to investigate carbon dioxide and GDP industry development (Wang & Nie, 2012). Next, Su and Lu (2012) use co-integration method and cross regional panel data to test the link between carbon dioxide and GDP in manufacturing structural transformation in China. Whereas, there is unidirectional relationship between carbon dioxide and GDP in manufacturing by using Toda and Yomamoto granger causality test. Ang (2008) used time series analysis to test the relationship between carbon dioxide and GDP in manufacturing in France. Autoregressive Distributed Lag (ARDL) test, Granger causality test have been used by Lin, Mourabrak and Ouyang (2014) to examine the relationship between manufacturing and carbon dioxide. Most of the research use EKC hypothesis which is U shape relationship between carbon dioxide and GDP to provide evidence to support EKC in European (Liu, 2007). In China, Liu (2007) conducted the relationship between food industry and carbon emission by using the LMDI test. Next is Index decomposition analysis (IDA) and structural decomposition analysis (SDA) are used by Liang and Zhang (2011) to analyze the significant of carbon dioxide emission and driving in China. Sheinbaum-Pardo, Mora-Perez, and Robles-Morales (2012) found that there is significant relationship between energy consumption and carbon dioxide emission in Mexico's industry sector by using Arithmetic Mean Divisia indext (AMDI).

2.2.8 GDP in services and carbon dioxide

Tang, Shang, Shi, Liu and Bi (2014) claimed that there is positive relationship between carbon dioxide and GDP in services sector. The reason is because tourism is growing over time and this will lead to increasing the carbon dioxide emission. The carbon dioxide emissions mostly are comes from the transportation, accommodation, tourist activities. There is long run relationship between carbon dioxide and GDP in tourism sector which mean the tourism increases will contribute to economic growth. Hence, this will increase the carbon dioxide emission through tourisms activity (Lee & Brahmasrene, 2013; Katirioglu, 2014). In year 2003 to year 2012, the transportation of tourism was increased thus led to carbon dioxide emission to rapidly increases. Furthermore, Albalate and Bel (2010); Adams and Jeanrenaud (2008) found that there is significant and positive causes economic growth in European countries will bring up the tourism and hence will conducted carbon dioxide emission will continuously increase. For instance, Tovar and Lockwood (2008) claimed that the establishment of infrastructure services will affect the environment degradation and climate will change accordingly through the carbon dioxide emission. Tourism mostly depends on transportation and this will lead air pollution (Bode, Hapke & Zisler, 2003). In Turkey, Katirioglu (2014) pointed out that there is positive and long run equilibrium between carbon dioxide emissions. When international tourism is expanding over years then air pollution slowly increase.

Besides that, Ucak, Asian and Turgut (2015) found that there is positive relationship between high income countries will have more opportunity to travelling and will increases the tourisms sector, therefore will contribute to carbon dioxide emission increases. Moreover, transport is a main factor of cause carbon dioxide emission increases, which have significant relationship between GDP in services and environmental pollution (Timilsina & Shrestha, 2009). In Austria, Lee and Brahmasrene (2013) investigate the heavy truck on the transport industry have correlation between carbon dioxide emission. Solis and Sheinbaum (2013) claimed that transports are mostly generating by using gasoline, diesel with heavy duty freight vehicle which will release carbon dioxide into atmosphere. Xu and Lin (2015) suggested that the transformation of transportation will result the air pollution increases as energy consumption is needed by transportation. Wang, Liao, Huang and Deng (2011) examine that transport model will contribute the carbon dioxide emission.

Zhang (2011) concluded that high way transport consume more energy and will cause air pollution. When motor vehicle population establish in the Taiwan, energy consumption by the vehicular will increases and carbon dioxide emission will continuously increases (Lin, 2010). Saboori et al. (2012) proven that there is long run relationship between economic growth, the transportation sector will be growing and therefore carbon dioxide will increases. Andreoni and Galmarinim (2012); Chandran and Tang (2013) studies that economic expand will lead to transportation sector increase and thus will leading to carbon emission increases in Europe and ASEAN country. Noceraand Cavallaro (2012) claimed that the factor cause carbon dioxide emission is machinery form working the highway tunnel construction. Tol (2007) concluded that there is significant relationship between greenhouse gases (GHG) from road construction project in Korea.

Wu and Shi (2011); Becken and Patterson (2006); Perch Nielsen, Sesartic and Stucki (2010) examined the relationship between carbon dioxide emission and services by using bottom up analysis and top down analysis. Tang, Shang, Shi, Liu and Bi (2014) used panel co-integration techniques, fixed effect model and Time series dynamic to determine the significant relationship between carbon dioxide emission and tourism. Saboori et al. (2012) used co-integration method to determine the link between transport sector's combustion of fossil fuel or gas release into atmospheres and leading to air pollution.

Saboori et al. (2012) used time series econometric model to study the long run relationship between transportation sector and carbon dioxide emission in OECD countries. Sabuhoro and Larue (1997) claimed using the ADF test to determine the relationship between carbon dioxide and transportation. Tian, Zhu, Lai and Lun (2014) used Divisia index method to determine freight road transport emission. Tian et al. (2014) used Partial Least Square approach to estimate correlation between carbon dioxide emission and transport sector in China. Nerveless, Kou and Chen (2009) suggested input-output life cycle assessment (LCA) to estimate the carbon dioxide emission and road construction in Irish. Carbon footprint also is one of the tool to estimate the carbon dioxide form transportation construction project (Sun, 2014). Lee and Brahmasrene (2013) used panel co-integration techniques and fixed effect model to estimate the long run equilibrium relationship between tourisms and carbon dioxide.

2.3 Finding the gaps

Based on previous studies, there are a few of shortcomings that need to be highlighted in order to carry out a more precise research. One of the gaps is many studies of convergence covered the panel sectors only. Many studies do not included information that significantly covered GDP by sector which is manufacturing, agriculture, services, capital, labour, foreign trade and more. Previous studies could be improved by including additional variables or focuses on which sectors they wish to study precisely.

Most of the studies concerned with the analysis of the environmental Kuznets curve (EKC), which stated that per capita income and environmental health indicators have an inverted U-shape relationship. Studies on EKC hypothesis used cross sectional data to analyses the developing country which is to establish the link between GDP and environmental degradation (carbon dioxide emission). But Fodha and Zaghdoud(2010) showed that Malaysia economy does not exist the environmental Kuznet curve (EKC) hypothesis. Malaysia is lack of common EKC hypotheses to estimate accurate carbon dioxide emission release to atmosphere by sector because the estimation of carbon dioxide emission in Malaysia was reported in whole country. Malaysia does not classify and estimate the carbon dioxide into sector because in agriculture, manufacturing and services do not use EKC to estimate (Saboori, Sulaiman & Mohd, 2012).

Next, the aggregated mitigation potential of CO_2 emissions in manufacturing industry is unclear thus far. Lacking of data also reduce the accuracy of the results. To design appropriate policies, a clear exposition of potential to mitigate CO_2 emission is needed. Because of the advances in energy utilization efficiency, carbon emission factors of all types of energy are changing over time. Theoretically, changes in fossil fuel emission factors are assumed to be constant because of tiny variations and data availability. The emission coefficient effect has been ignored by most studies (Yan & Fang, 2015).

The other gaps is related with time horizon applied, which consider short, although other studies reported in the literature, have used timeframes also reduced (Mulder & Groot, 2012). Service sectors are considered as not important direct polluters and have lower emission intensities per unit of output than other sectors of the economy. They are viewed as 'non-material' activities. But, service provision can indirectly impact on other sectors' pollution because of their production is needed for the provision (Gallouj & Djellal, 2015).

2.4 Conclusion

This chapter has discussed about the bidirectional relationship between renewable energy, carbon dioxide, and GDP by sectors in various countries. The hypothesis was developed from the theories and literature review.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter discusses data description and econometric techniques. Data description showed the summary of the variables used in the study and the data sources obtained. It gives a clearer description about the variables used in order to determine the relationship between GDP per sector, renewable energy and carbon dioxide. Unit root test and Autoregressive Distributed Lag (ARDL) approach are included in this chapter to eliminate bias issues and econometric problems. Logarithm is added into the equation to simplify and linearize the relationship in the model. This study examines the data from year 1990 to 2011 which has a sample size of 22 years.

3.1 Data Description

To determine the relationship of renewable energy and carbon dioxide which impact on 3 different sectors of GDP which is agriculture (ARG), manufacturing (MAN) and services (SER), therefore the economic model is developed as follow.

3.1.1 Economic Model

$Y_i = f(\log RE)$ $\qquad$ $LogRE = f(Y_i)$

While Y_i is GDP, logAGR, logMAN and logSER

Written as specific form:

$\log AGR_t = \alpha_0 + \alpha_1 \log RE_t + \varepsilon_{1t}$ $\qquad$ $\log RE_t = \alpha_0 + \alpha_1 \log AGR_t + \varepsilon_{2t}$

$\log MAN_t = \lambda_0 + \lambda_1 \log RE_t + \varepsilon_{3t}$ $\qquad$ $\log RE_t = \lambda_0 + \lambda_1 \log MAN_t + \varepsilon_{4t}$

$\log SER_t = \beta_0 + \beta_1 \log RE_t + \varepsilon_{5t}$ $\qquad$ $\log RE_t = \beta_0 + \beta_1 \log SER_t + \varepsilon_{6t}$

$GDP_t = \gamma_0 + \gamma_1 \log REt + \varepsilon_{7t}$ $\qquad$ $\log RE_t = \gamma_0 + \gamma_1 GDP_t + \varepsilon_{8t}$

$\log CO_2 = f(\tilde{\alpha}_i)$ $\qquad$ $\tilde{\alpha}_i = f(\log CO_2)$

While $\tilde{\alpha}_i$ is GDP, logAGR, logMAN and logSER

Written as specific form:

$\log CO_{2t} = \alpha_0 + \alpha_1 \log AGR_t + \varepsilon_{9t}$ $\qquad$ $\log AGR_t = \alpha_0 + \alpha_1 \log CO_{2t} + \varepsilon_{10t}$

$\log CO_{2t} = \lambda_0 + \lambda_1 \log MAN_t + \varepsilon_{11t}$ $\qquad$ $\log MAN_t = \lambda_0 + \lambda_1 \log CO_{2t} + \varepsilon_{12t}$

$\log CO_{2t} = \beta_0 + \beta_1 \log SER_t + \varepsilon_{13t}$ $\qquad$ $\log SER_t = \beta_0 + \beta_1 \log CO_{2t} + \varepsilon_{14t}$

$\log CO_{2t} = \gamma_0 + \gamma_1 GDP_t + \varepsilon_{8t}$ $\qquad$ $GDP_t = \gamma_0 + \gamma_1 \log CO_{2t} + \varepsilon_{8t}$

3.1.2 Sources of Data and Definitions

Table 3.1 Summary of Variable and Data Sources

Variables	Indicator name	Unit Measurement	Source of data
Gross Domestic Product (Agriculture)	LNAGR	% of GDP	World Bank Indicator
Gross Domestic Product (Manufacturing)	LNMAN	% of GDP	World Bank Indicator
Gross Domestic Product (Services)	LNSER	% of GDP	World Bank Indicator
Gross Domestic Product	GDP	GDP Growth	World Bank Indicator
Renewable Energy	LNRE	% of total final energy	World Bank Indicator
Carbon Dioxide Emissions	$LNCO_2$	Metric tons per capita	World Bank Indicator

3.1.3 Variables and Measurement

3.1.3.1 Gross Domestic Product

Gross domestic product defined as the total market value of all final goods and services produced in a country in a given year which equal to total consumer, investment and government spending and the net export (WorldBank, 2010). GDP also measure as the total of consumer spending, investment, government spending, and net export. GDP per capita is the unit measurement for GDP which measure from GDP by the population. The GDP data was collected from the World Bank Indicator in the period of year 1990 to year 2011.

3.1.3.2 Gross Domestic Product (Agriculture)

Agricultural output is one of component of the GDP of a nation. Agriculture sectors to GDP include food service, eating and drinking places, textile, apparel and leather manufacturing, food, beverage, and tobacco manufacturing, forestry, fishing, and related activities which contributed to the GDP (WorldBank, 2010). The percentage of GDP acts as the unit measurement for the GDP agriculture. The GDP agriculture data was collected in year 1990 to year 2011 from World Bank Indicator.

3.1.3.3 Gross Domestic Product (Manufacturing)

Manufacturing output is one of the components from the GDP of a nation. The percentage of GDP is the unit measurement for GDP manufacturing. The period of GDP manufacturing data from year 1990 until year 2011 and these collected from World Bank Indicator (WorldBank, 2010). Manufacturing is the largest segment of sector of the economy. Manufacturing is the production of merchandise which are fertilizers and fuels, but excluded real estate which dominated by attributed and actual rental income on property.

3.1.3.4 Gross Domestic Product (Services)

GDP services defined as the production that contributes to the communication, government, transportation, construction, restaurant, trade, financing, insurance, real estate and social and personal services. Increments in income lead to the growth of services sector. The personal incomes and consumption of services sector are positively relationship. The services sector may influences by the consumption behavior (WorldBank, 2010). The percentage of GDP is the unit measurement of the GDP services. The GDP services data was collected from the World Bank Indicator which from year 1990 to year 2011.

3.1.3.5 Carbon Dioxide Emissions (CO_2)

Carbon Dioxide is a type of gas vital to life on Earth which is odorless and colorless. CO_2 produced by all aerobic organisms with respiration and the combustion carbohydrates and fossil fuels such natural gas, petroleum, and coal. The rapidly increases of CO_2 tend to global warming and climate change (WorldBank, 2010). A metric ton per capita is the unit measurement of CO_2. The CO_2 data was collected from year 1990 to year 2011 from World Bank Indicator.

3.1.3.6 Renewable Energy

Renewable energy represents as any energy resources which are naturally regenerated on a human timescale such as hydropower, geothermal, biomass, solar, and wind (OECD, 2010). The renewable energy data was collected from the World Data Indicator in year 1990 to year 2011. Percentage of the final energy consumption acts as the unit measurement for renewable energy.

3.2 Econometric Techniques

This study applied time series method to forecast and estimate the research model. By using time series method, estimation and forecasting can be more accurate where the study only focus in one country with series of time periods. This study is to investigate the relationship between renewable energy, carbon dioxide and gross domestic product (GDP) by sector in agriculture, manufacturing and services. By examining the relationship, ARDL approach is applied.

3.2.1Augmented Dickey-Fuller (ADF)

Augmented Dickey-Fuller (ADF) is a unit root test in time series method to check the stationary of each variable. ADF is a negative number where the more negative the number, the stronger rejection of the hypothesis at some level of the confidence.

To compute test statistic:

$$\Delta logYt = \alpha + \beta logYt-1 + \delta t + X\ k\ j=1\ \zeta j \Delta logYt-j + et$$

The null and hypothesis statement are as follows:

H_0: All variables contain unit root and are not stationary

H_1: All variables do not contain unit root and are stationary

If the probability value is lower than significance level, the null hypothesis will be rejected and the model is stationary.

If the results showed stationary at level of confidence, the variables are consider as I(0). If the results showed stationary at first difference level of confidence, the variables are I(1). The study can then moves to the next step by performing diagnostic checking after achieving stationary.

3.2.2 ARDL Approach to Co-integration

This study practices autoregressive distributed lag (ARDL) technique recommended by Pesaran, Shin and Smith (2001).By using ARDL method, the estimated standard errors are no longer biased and the long-run parameter estimates are efficient. The ARDL parameters are also can be freely estimated. ARDL approach generates consistent evaluation for the long-run coefficients between variables in levels, whether the underlying regressors are I(O), I(1) or mutually co-integrated but not I(2) (Pesaran et al., 2001). The advantages of using

ARDL method are, first it involves a single equation set-up, making it simple to implement and interpret. Next, different variables can be assigned to different lag-lengths as they enter the model with small sample size data (Giles, 2013).

ARDL regression model in the basic form:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \ldots\ldots. + \beta_p Y_{t-p} + \alpha_0 X_t + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \ldots\ldots\ldots + \alpha_q X_{t-q} + \varepsilon_t$$

To investigate the relationship between renewable energy, carbon dioxide and GDP by sector, this study examines the effect of renewable energy and carbon dioxide on the proportional GDP in the sectors of Agriculture (AGR), Manufacturing (MAN) and Services (SER) during 1990 to 2011 in Malaysia.

The unrestricted error correction model (UECM) is isolated as:

While Y is, AGR, MAN, SER

$$\Delta \log Y_t = \sum_{i=0} logY_{1i}\ \Delta \log Y_{t-1} + \sum_{i=0} logY_{2i}\ \Delta\ \log RE_t + \beta_0 \log Y_{t-1} + \beta_1 \log RE_{t-1} + \varepsilon_t$$

$$\Delta GDP_t = \sum_{i=0} Y_{1i}\ \Delta GDP_{t-1} + \sum_{i=0} Y_{2i}\ \Delta\ \log RE_t + \beta_0 GDP_{t-1} + \beta_1 \log RE_{t-1} + \varepsilon_t$$

$$\Delta \log RE_t = \sum_{i=0} logY_{1i}\ \Delta \log RE_{t-1} + \sum_{i=0} logY_{2i}\ \Delta\ \log Y_t + \beta_0 \log RE_{t-1} + \beta_1 \log Y_{t-1} + \varepsilon_t$$

$$\Delta \log RE_t = \sum_{i=0} logY_{1i}\ \Delta \log RE_{t-1} + \sum_{i=0} logY_{2i}\ \Delta\ GDP_t + \beta_0 \log RE_{t-1} + \beta_1 GDP_{t-1} + \varepsilon_t$$

While $\tilde{\alpha}_i$ is AGR, MAN, SER

$\Delta logCO_{2t} = \sum_{i=0} Y_{1i} \Delta logCO_{2t-1} + \sum_{i=0} Y_{2i} \Delta log\tilde{\alpha}_t + \beta_0 logCO_{2t-1} + \beta_1 log\tilde{\alpha}_{t-1} + \varepsilon_t$

$\Delta logCO_{2t} = \sum_{i=0} Y_{1i} \Delta logCO_{2t-1} + \sum_{i=0} Y_{2i} \Delta GDP_t + \beta_0 logCO_2t_{-1} + \beta_1 GDP_{t-1} + \varepsilon_t$

$\Delta log\tilde{\alpha}_t = \sum_{i=0} Y_{1i} \Delta log\tilde{\alpha}_{t-1} + \sum_{i=0} Y_{2i} \Delta logCO_{2t} + \beta_0 log\tilde{\alpha}_{t-1} + \beta_1 logCO_{2t-1} + \varepsilon_t$

$\Delta GDP_t = \sum_{i=0} Y_{1i} \Delta GDP_{t-1} + \sum_{i=0} Y_{2i} \Delta logCO_{2t} + \beta_0 GDP_{t-1} + \beta_1 logCO_{2t-1} + \varepsilon_t$

The null and alternative hypothesis statements are expressed as below:

$$H_0: \beta_0 = \beta_1 = 0$$
$$H_1: \beta_0 \neq \beta_1 \neq 0$$

The hypotheses statement stated that the three models are not co-integrated. F-statistic is used to investigate the hypothesis statement which has non-standard asymptotic distribution.

Pesaran et al. (2001) reported accurate and suitable critical values for different regresses numbers and whether the model included intercept or trend term. Two set of critical values are stated where one set assumes all variables are I(0) and the other set are I(1), giving the critical bound covered all variables categorized into I(0) and I(1).

Narayan and Narayan (2004) stated that the F-statistic follows non-standard distribution which depends on few criteria:

I) Whether the variables are included in the unrestricted error correction model (UECM) are integrated order of 0 or 1

II) Whether the UECM consist of drift

III) How many independent variables are included

According to Pesaran et al. (2001), if the F-statistic is lower than the lower critical bound, the null hypothesis will not be rejected and there is no long run relationship existed between the variables. Conversely, if the F-statistic is higher than the upper critical bound, this study could reject the null hypothesis and conclude that there is long run relationship in the model. But in case the F-statistic falls between the lower and upper critical bound, the test is inconclusive.

Co-integration is established to apply ARDL conditional long run model as follow:

While Y is, AGR, MAN, SER

$$logY_t = \theta_2 + \sum_{i=0} \lambda_{1i} + logY_{t-1} + \sum_{i=0} \lambda_{2i} logRE_t + \varepsilon_t$$
$$GDP_t = \theta_2 + \sum_{i=0} \lambda_{1i} + GDP_{t-1} + \sum_{i=0} \lambda_{2i} logRE_t + \varepsilon_t$$

$$logRE_t = \theta_2 + \sum_{i=0} \lambda_{1i} + logRE_{t-1} + \sum_{i=0} \lambda_{2i} logY_t + \varepsilon_t$$
$$logRE_t = \theta_2 + \sum_{i=0} \lambda_{1i} + logRE_{t-1} + \sum_{i=0} \lambda_{2i} GDP_t + \varepsilon_t$$

While $\tilde{\alpha}_i$is AGR, MAN, SER

$$logCO_{2t} = \theta_2 + \sum_{i=0} \lambda_{1i} + logCO_{2t-1} + \sum_{i=0} \lambda_{2i} log\tilde{\alpha}_t + \varepsilon_t$$
$$logCO_{2t} = \theta_2 + \sum_{i=0} \lambda_{1i} + logCO_{2t-1} + \sum_{i=0} \lambda_{2i} GDP_t + \varepsilon_t$$

$$log\tilde{\alpha}_t = \theta_2 + \sum_{i=0} \lambda_{1i} + log\tilde{\alpha}_{t-1} + \sum_{i=0} \lambda_{2i} logCO_{2t} + \varepsilon_t$$
$$GDP_t = \theta_2 + \sum_{i=0} \lambda_{1i} + GDPt_{-1} + \sum_{i=0} \lambda_{2i}\ logCO_{2t} + \varepsilon_t$$

In the final step, error correction model (ECM) is applied. The ECM sets up error correction term related with the long run equations to form short run model which specified as follow:

While Y is, AGR, MAN, SER

$\Delta logY_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta logY_{t-1} + \sum_{i=0} \varphi_{2i} \Delta logRE_t + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta GDP_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta GDP_{t-1} + \sum_{i=0} \varphi_{2i} \Delta logRE_t + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta logRE_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta logRE_{t-1} + \sum_{i=0} \varphi_{2i} \Delta logY_t + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta logRE_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta logRE_{t-1} + \sum_{i=0} \varphi_{2i} \Delta GDP_t + {}_\delta ect_{t-1} + \varepsilon_t$

While $\tilde{\alpha}_i$is AGR, MAN, SER

$\Delta logCO_{2t} = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta logCO_{2t-1} + \sum_{i=0} \varphi_{2i} \Delta log\tilde{\alpha}_t + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta logCO_{2t} = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta logCO_{2t-1} + \sum_{i=0} \varphi_{2i} \Delta GDP_t + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta log\tilde{\alpha}_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta log\tilde{\alpha}_{t-1} + \sum_{i=0} \varphi_{2i} \Delta logCO_{2t} + {}_\delta ect_{t-1} + \varepsilon_t$

$\Delta GDP_t = \theta_3 + \sum_{i=0} \varphi_{1i} \Delta GDP_{t-1} + \sum_{i=0} \varphi_{2i} \Delta logCO_{2t} + {}_\delta ect_{t-1} + \varepsilon_t$

The adjustment coefficient ECT_{t-1} how long the model can adjust to reach long run equilibrium by capturing the long run model's residual.

3.3 Diagnostic Checking

3.3.1 JarqueBera Normality (JB) Test

In statistic, JarqueBera normality test was developed by Jarque and Bera (1980) and it is a goodness-of-fit test of sample data whether it has skewness and kurtosis to match a normal distribution. In hypothesis testing, the null hypothesis is rejected when p-value is less than significance level. Null hypothesis is an error term which is normally distributed while the alternative hypothesis is an error term which is not normally distributed.

3.3.2 Breusch-Godfrey LM Test

Breusch-Godfrey LM Test also known as LM test for serial correlation is used to test for the serial dependence that has not been included in a proposed model. Sometimes autocorrelation in residuals can be caused by the omission of the relevant variables or incorrect functional form in the model. Durbin-Watson and Durbin’s h test is also similar to Breusch-Godfrey LM test but LM test takes into account which higher orders of the lagged dependent variables and higher orders of serial correlation (Gujarati & Dawn, 2009). For the hypothesis testing, null hypothesis stated that there is no autocorrelation while alternative hypothesis stated that there is an autocorrelation. Reject null hypothesis if p-value is less than significance level.

3.3.3 Autoregressive Conditional Heteroscedasticity (ARCH) Test

In general, to test for heteroscedasticity in economic model, white test is applied however ARCH test is applied when time series data is used. The test is developed by Engle (1982) which only applicable for time series data analysis. Heteroscedasticity can assume that the model errors are uniform and uncorrelated which dive to greater t-statistic or f-statistic value, cause the variances to be underestimated by Ordinary

Least Squares estimator. As the hypothesis testing, null hypothesis stated that there is no heteroscedasticity problem while the alternative hypothesis stated that there is heteroscedasticity problem. Reject null hypothesis if the p-value is less than significance level.

3.3.4 Ramsey RESET Test

Ramsey RESET test is used to test for model specification in linear regression model. It can use to test whether non-linear combination of the values could explain the response variables. The test was developed as to detect incorrect functional form of the variables in a model. When irrelevant variables will mislead and form inaccurate conclusion. The null hypothesis will be rejected if the p-value is lower than significance level indicates there is a misspecification problem in the model.

3.3.5 CUSUM and CUSUMSQ Test

In general, the CUSUM and CUSUMSQ test are used to test the constancy of coefficients in a model. The tests is used on the first observations and plotted against breaking point. It can be used without prior knowledge about the date of structural breaks. If the plot falls within the range of 5% significant level, the coefficients are stable.

3.4 Conclusion

Chapter 3 has discussed about all the test of the study. The Augmented Dickey-Fuller (ADF) is used to check the stationary of the variables, while the ARDL model is used to determine the short run and long run relationship between renewable energy, carbon dioxide, the GDP per sector in Malaysia. There have 5 diagnostic checking are used to ensure the model is free from economics problems.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

The results of short run and long run relationship between GDP and renewable energy, GDP and CO_2, renewable energy and CO_2 will be discussed in this chapter.

4.1 Unit root test

Table 4.1 showed the result of Augmented Dickey-Fuller unit root test for GDP by sector in agriculture, manufacturing and services, CO_2 and renewable energy at level form and first difference form. The variables are consider as I(0) if the result showed stationary at level form where the variables are consider as I(1) if the result showed stationary at first difference form.

Table 4.1Result of Augmented Dickey-Fuller Unit Root Test for the variables in Malaysia.

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
GDP	-4.371120 **	-6.215626 ***
AGR	-0.895680	-3.972404 ***
MAN	-1.260782	-3.844885 ***
SER	-2.255671	-4.881841 ***
CO2	-2.740913	-5.040995 ***
RE	-0.349258	-2.960730 *
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.		

4.2 Result of Diagnostic Checking

Diagnostic checking such as JarqueBera normality test, Serial Correlation LM test, ARCH test, Ramsey RESET test, CUSUM and CUSUM square test were carried out in order to ensure that the model is free from economic problems.

Table 4.2 Result of Diagnostic Checking for GDP and Renewable Energy in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBeranormalitytest	6.514857	0.038487 **	Not normally distributed
Serial Correlation LM test	1.397051	0.4973	No autocorrelation problem
ARCH test	0.446810	0.5039	No heteroscedasticity problem
Ramsey RESET test	2.898930	0.1093	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test is 0.038487, which is less than α at 0.05, it means the error term was not normally distributed. While, the P-value of Serial Correlation LM test (0.4973), ARCH test (0.5039), Ramsey RESET test (0.1093) are more than α at 0.05, meaning that the error term do not have autocorrelation problem, no heteroscedasticity problem and also do not have model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

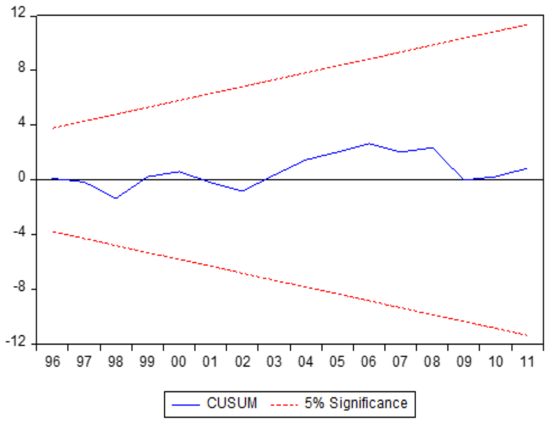


Figure 4.1

CUSUM Square Test

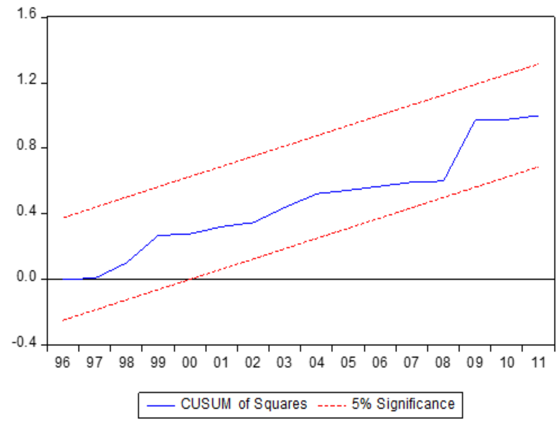


Figure 4.2

Figure 4.1 and 4.2 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

Table 4.3 Result of Diagnostic Checking for CO2 and GDP in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	2.296352	0.317215	Normally distributed
Serial Correlation LM test	4.407539	0.1104	No autocorrelation problem
ARCH test	0.008304	0.9274	No heteroscedasticity problem
Ramsey RESET test	2.711687	0.1204	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.317215), Serial Correlation LM test (0.1104), ARCH test (0.9274) and Ramsay RESET test (0.1204) are more than α at 0.05, which mean that the error term was normally distributed, no autocorrelation problem , no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

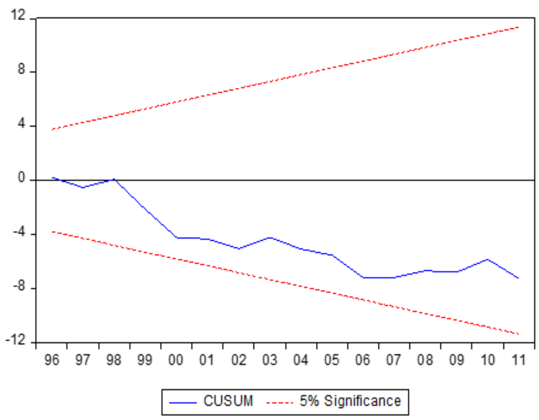


Figure 4.3

CUSUM Square Test

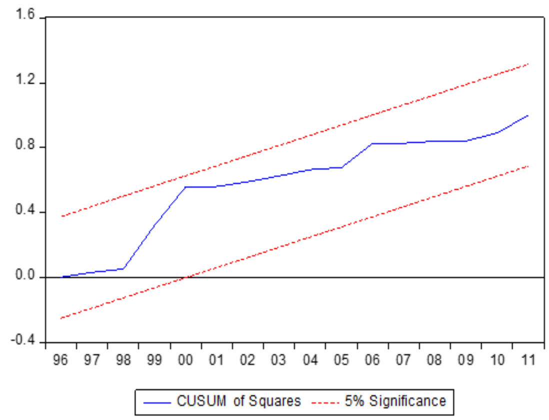


Figure 4.4

Figure 4.3 and 4.4 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

Table 4.4Result of Diagnostic Checking for Agriculture and Renewable energy in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	3.242848	0.197617	Normally distributed
Serial Correlation LM test	2.397592	0.6631	No autocorrelation problem
ARCH test	4.286245	0.3687	No heteroscedasticity problem
Ramsey RESET test	0.756959	0.4069	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.197617), Serial Correlation LM test (0.6631), ARCH test (0.3687) and Ramsay RESET test (0.4069) are more than α at 0.05, which mean that the error term was normally distributed, no autocorrelation problem, no heteroscedasticity problem andalso no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

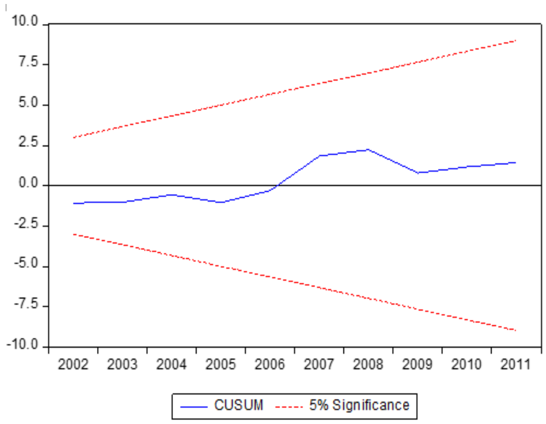


Figure 4.5

CUSUM Square Test

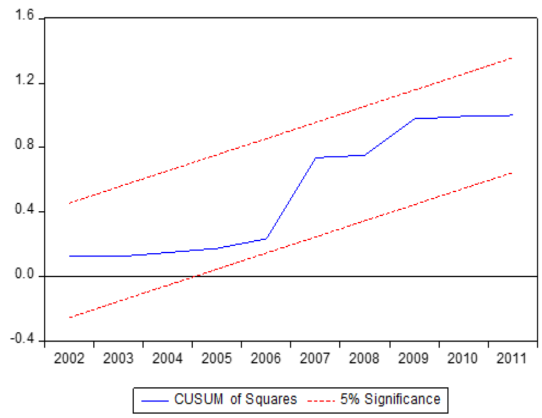


Figure 4.6

Figure 4.5 and 4.6 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

<u>Table 4.5 Result of Diagnostic Checking for CO2 and Agriculture in Malaysia.</u>

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	0.303265	0.859304	Normally distributed
Serial Correlation LM test	0.276372	0.8709	No autocorrelation problem
ARCH test	0.016229	0.8986	No heteroscedasticity problem
Ramsey RESET test	0.780761	0.3892	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.859304), Serial Correlation LM test (0.8709), ARCH test (0.8986) and Ramsay RESET test (0.3892) are more than α at 0.05, which mean the error term was normally distributed, no autocorrelation problem, no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

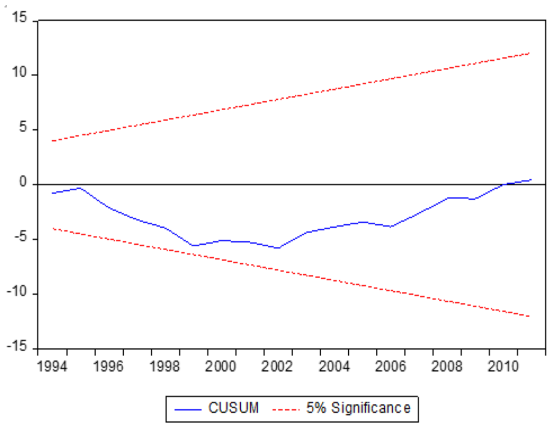


Figure 4.7

CUSUM Square Test

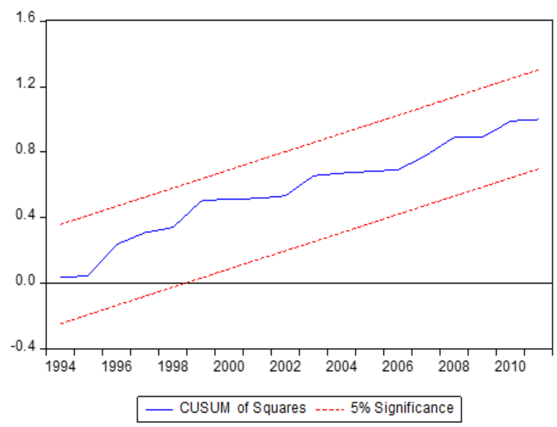


Figure 4.8

Figure 4.7 and 4.8 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

Table 4.6 Result of Diagnostic Checking for Manufacturing and Renewable energy in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	0.016361	0.991853	Normally distributed
Serial Correlation LM test	0.002913	0.9570	No autocorrelation problem
ARCH test	0.696494	0.4040	No heteroscedasticity problem
Ramsey RESET test	0.746499	0.4004	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.991853), Serial Correlation LM test (0.9570), ARCH test (0.4040) and Ramsay RESET test (0.4004) are more than α at 0.05, which mean that the error term was normally distributed, no autocorrelation problem , no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

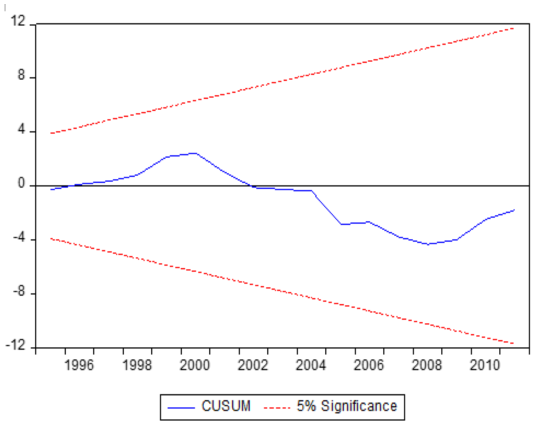


Figure 4.9

CUSUM Square Test

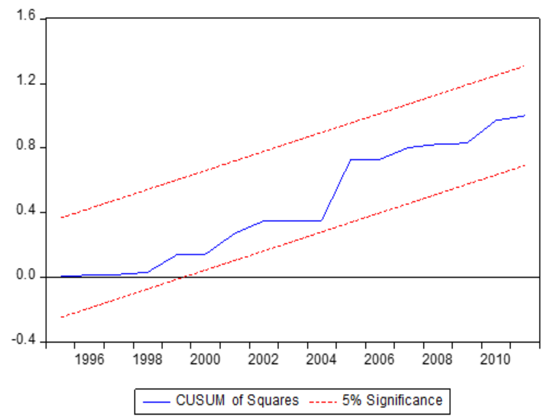


Figure 4.10

Figure 4.9 and 4.10 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

<u>Table 4.7 Result of Diagnostic Checking for CO2 and Manufacturing in Malaysia.</u>

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	0.465608	0.792309	Normally distributed
Serial Correlation LM test	0.106244	0.9483*	No autocorrelation problem
ARCH test	0.563705	0.4528	No heteroscedasticity problem
Ramsey RESET test	1.737525	0.2049	No model misspecification bias
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The p-value of Jarque-Bera normality test (0.792309), Serial Correlation LM test (0.9483), ARCH test (0.4528) and Ramsey RESET test (0.2049) are more than α at 0.05, which mean the error term was normally distributed, no autocorrelation problem, no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

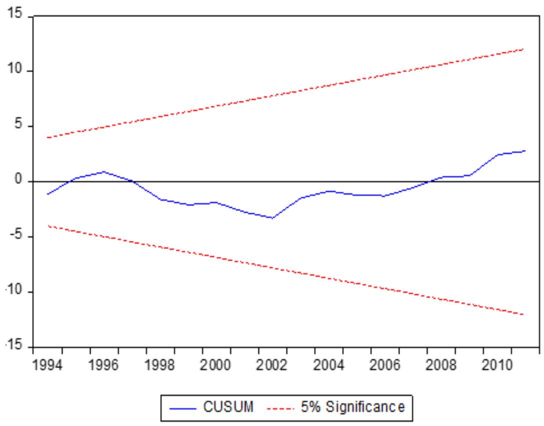


Figure 4.11

CUSUM Square Test

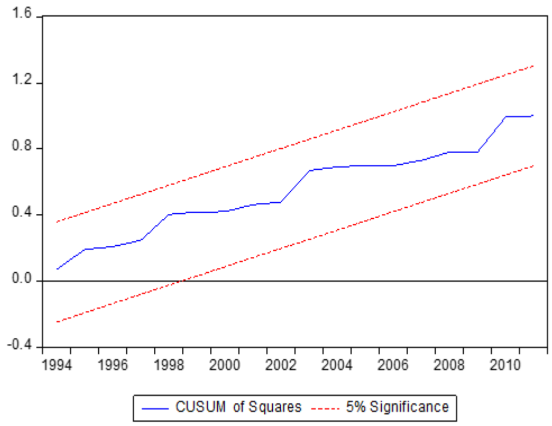


Figure 4.12

Figure 4.11 and 4.12 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

Table 4.8 Result of Diagnostic Checking for Services and Renewable Energy in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	0.377917	0.827821	Normality distributed
Serial Correlation LM test	0.810399	0.3680	No autocorrelation problem
ARCH test	0.169124	0.6809	No heteroscedasticity problem
Ramsey RESET test	0.203178	0.6586	No model misspecification error
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.827821), Serial Correlation LM test (0.3680), ARCH test (0.6809) and Ramsey RESET test (0.6586) are more than α at 0.05, which mean the error term was normally distributed, no autocorrelation problem, no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

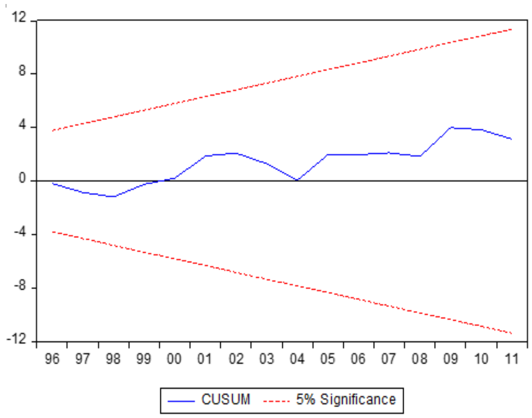


Figure 4.13

CUSUM Square Test

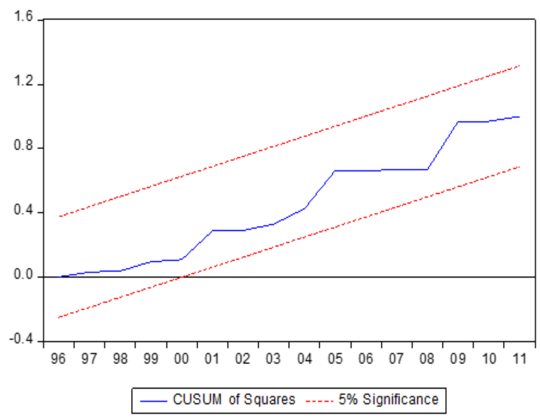


Figure 4.14

Figure 4.13 and 4.14 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

Table 4.9 Result of Diagnostic Checking for Services and Co2 in Malaysia.

Diagnostic testing	Chi-square/F-statistic	P-value	Conclusion
JarqueBera normality test	1.018644	0.600903	Normality distributed
Serial Correlation LM test	1.338197	0.5122	No autocorrelation problem
ARCH test	0.183572	0.6683	No heteroscedasticity problem
Ramsey RESET test	0.001436	0.9702	No model misspecification error
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

The P-value of Jarque-Bera normality test (0.600903), Serial Correlation LM test (0.5122), ARCH test (0.6683) and Ramsay RESET test (0.9702) are more than α at 0.05, which mean the error term was normally distributed, no autocorrelation problem , no heteroscedasticity problem and also no model misspecification bias. Therefore the null hypothesis is not rejected.

CUSUM Test

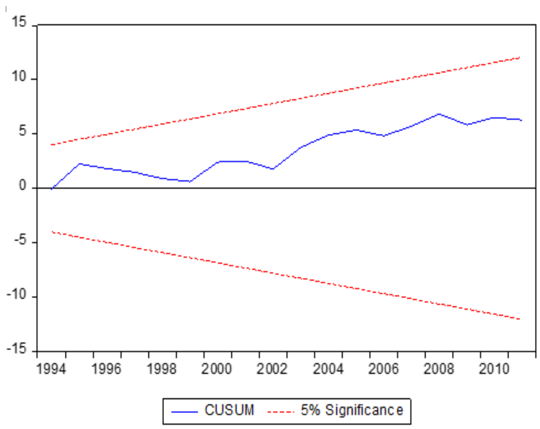


Figure 4.15

CUSUM Square Test

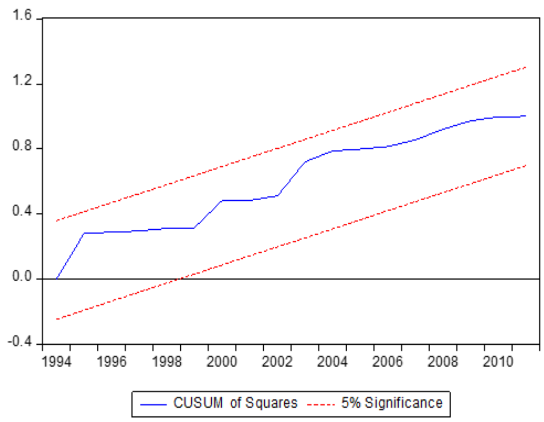


Figure 4.16

Figure 4.15 and 4.16 showed the coefficients are stable, as the plot of CUSUM and CUSUMSQ falls within the range of 5% significant level.

4.3 Bound Test for Co-integration

ARDL bound test is used to examine the existence of long run relationship between agriculture, manufacturing, services, gross domestic product, and macroeconomic variables. If F-statistic is greater than upper critical value bound, this indicates that there is a long run relationship. Otherwise, if F-statistic is less than lower critical values, this indicated that there is no long run relationship. While, if F-statistic is fall between upper and lower critical value, the decision is inconclusive. According to Pesaran et al.(2001), lower critical value that follows I(0) is 3.02 at significant level of 10%, while upper critical value that follows I(1) is 3.51. On the other hand, lower critical value that follows I(0) is 3.63 at significant level of 5%, while upper critical value that follows I(1) is 4.16 at significant level of 5%. Table below shows optimal lag length for each of the variables and there is long run relationship found between agriculture, manufacturing, services, gross domestic product and macroeconomic variables in Malaysia.

Table 4.10 Result of Bound Test for co-integration (Gross Domestic Product)

	Optimal lag length	F-Statistic	Conclusion
F_{RE} (GDP)	(1, 1)	12.16041***	Co-integration
F_{GDP} (RE)	(1, 1)	5.295517**	Co-integration
F_{GDP} (CO_2)	(1, 1)	9.465001***	Co-integration
F_{CO2} (GDP)	(2, 0)	3.478648*	Co-integration
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.11 Result of Bound Test for co-integration (Agriculture)

	Optimal lag length	F-Statistic	Conclusion
F_{RE} (AGR)	(1, 4)	5.600285**	Co-integration
F_{AGR} (RE)	(3, 0)	6.569583***	Co-integration
F_{AGR} (CO_2)	(1, 0)	3.895340*	Co-integration
F_{CO2} (AGR)	(1, 4)	5.186060**	Co-integration
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.12 Result of Bound Test for co-integration (Manufacturing)

	Optimal lag length	F-Statistic	Conclusion
F_{RE} (MAN)	(1, 0)	2.618925	No Co-integration
F_{MAN} (RE)	(4, 4)	2.465658	No Co-integration
F_{MAN} (CO_2)	(1, 1)	6.548346***	Co-integration
F_{CO2} (MAN)	(1, 0)	1.382568	No Co-integration
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.13 Result of Bound Test for co-integration (Services)

	Optimal lag length	F-Statistic	Conclusion
F_{RE} (SER)	(1, 1)	5.227299**	Co-integration
F_{SER} (RE)	(1, 0)	6.462766***	Co-integration
F_{SER} (CO_2)	(1, 0)	4.535743**	Co-integration
F_{CO2} (SER)	(1, 0)	0.272563	No Co-integration
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

4.4 The relationship between GDP and renewable energy in Malaysia

4.4.1 Does renewable energy granger cause GDP?

Table 4.14 Estimated long run coefficient of ARDL approach (Renewable energy granger cause GDP in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNRE	27.448866	12.101794	2.268165(0.0375)**
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively.			

Table 4.14 illustrated the result of long run coefficient of GDP and renewable energy in Malaysia. The estimated coefficients for renewable energy indicate a positive long run impact on GDP. An economy that functions in a causal relationship is less energy dependent; hence any conservative policies which concern about energy consumption may have little or no adverse effect on economic growth. Increase in economy may cause an increase in energy consumption (Ozturk, 2010). When there is a 1% increase in renewable energy consumption, there will be 27.4489% increase in the country real GDP. The decrease in energy consumption may not necessary bring negative impact on GDP growth as the greenhouse reduction measure can be pursued as causality does not run from energy consumption to GDP growth (Menegaki, 2014).

This result is also supported by Alper and Oguz (2015). According to their empirical results, renewable energy consumption has positive impacts on economic growth. The development of renewable energy has a positive impact with the economic growth. By reduce the import fossil fuels, it could create an opportunities for exporting renewable energy components and facilities, and investing in renewable energy sources, such as wind power plants and solar photovoltaic modules (Blazejczak, Braun, Elder & Schill, 2014).

Table 4.15 Estimated short run coefficient of ARDL approach (Renewable energy granger cause GDP in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNRE)	-23.965988	12.356192	-1.939593(0.0703)*
ECT_{t-1}	-0.904778	0.172450	-6.406355(0.0000)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively.			

In table 4.15, as for the short run, the result shows that the model is insignificant at 10% level, but the estimated coefficient shows a negative relationship with the GDP. Alper and Oguz (2015) stated that the result in short run does not represent that energy consumption and GDP are not interrelated. However, the main reason to have an insignificant relationship is the fact that developing countries have less renewable energy in their energy portfolio than other developed countries. In order to carry out renewable energy projects, it involves a huge among of funds, most of the companies and FDI would not invest in short run to avoid losses. FDI do not have the confidence to invest in renewable energy in Malaysia since the technology is immature yet while Malaysia does not have a conclusive renewable energy policy.

Analysis of the ECT_{t-1}, support the idea of a co-integrating relationship between renewable energy and GDP. The estimated coefficient for

ECT_{t-1} is negative and statistically significant across the equations at -0.904778.

4.4.2 Does GDP granger cause renewable energy?

Table 4.16 Estimated long run coefficient of ARDL approach (GDP granger cause Renewable energy in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
GDP	-0.145398	0.250427	-0.580601(0.5691)
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively.			

Table 4.16 illustrated the result of long run relationship between renewable energy and GDP in Malaysia. The result shows insignificant relationship between renewable energy and GDP at 5% significant level in the long run. It indicates that increase in GDP does not necessary related to increase in renewable energy in Malaysia. Kulionis (2013) stated that the energy consumption is a relatively small component of GDP and thus energy consumption should not have significant impact on economic growth. Nevertheless it is still important to discuss the main challenges and benefits that come from the investment in renewable energy sources.

Table 4.17 Estimated short run coefficient of ARDL approach (Renewable energy and GDP in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(GDP)	-0.005588	0.002118	-2.638429(0.0173)**
ECT_{t-1}	-0.045685	0.010842	-4.213734(0.0006)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively.			

As for the short run, table 4.17 shows that the relationship between renewable energy and GDP in Malaysia is significant at 5% level but the coefficient shows a negative relationship. It can only be expected that in the short run, Malaysia government does not emphasis on developing renewable energy technology to replace conventional energy. As a developing country, Malaysia needs more energy consumption in order to boot up the economy but invest in renewable energy require huge funding and stable technology. As result, renewable energy is not being concerned by the government in the short run to help with GDP growth.

Analysis of the ECT_{t-1}, support the idea of a co-integrating relationship between renewable energy and GDP. The estimated coefficient for ECT_{t-1} is negative and statistically significant across the equations at -0.045685.

As a conclusion, there is unidirectional causal relationship running from renewable energy to GDP in long run but in short run, there is unidirectional causal relationship running from GDP to renewable energy.

4.5 The relationship between carbon dioxide and GDP in Malaysia

4.5.1 Does GDP granger cause carbon dioxide?

Table 4.18 Estimated long run coefficient of ARDL approach (GDP granger cause carbon dioxide in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
GDP	0.035803	0.014741	2.428854(0.0273)**
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from Table 4.18 showed that the GDP have significant relationship with CO_2 in Malaysia in long run. The coefficient of GDP is significant with p-value 0.0273 at significance level of 1%, 5% and 10% for k=1. For every 1% increase in GDP growth, the CO_2 will increase 0.035% on average. Therefore, there is positive relationship between CO_2 and GDP.

Sun, Zhou and Zhang (2011) results showed positive co-integration relationship between GDP and CO_2, the reason is that resource-dependent city rely on mainly heavy industry, its tertiary industry is comparatively low, GDP is more related to high-carbon economy, and therefore economy with low carbon transition can strongly affect the economic growth in resource-dependent city. Begum, Sohag, Abdullah and Jaafar (2015) result showed GDP and CO2 emissions are positive and significant related. An increase in GDP growth causes the increase of CO_2 emissions. The main reason was the manufacturing sectors were expanded rapidly on Malaysia's economic growth from 1980 onwards.

Table 4.19 Estimated short run coefficient of ARDL approach (GDP granger cause carbon dioxide in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(GDP)	0.008872	0.002470	3.592125(0.0024)***
ECT_{t-1}	-0.476959	0.084389	-5.651936(0.0000)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.19 showed that the GDP have significant relationship with CO_2 in Malaysia in short run. The coefficient of GDP is significant with p-value 0.00 at significance level of 1%, 5% and 10% for k=1. For every 1% increase in GDP per capita, the CO_2 will increase 0.0088% on average. Therefore, there is positive relationship between CO_2 and GDP in short run.

Wang et al. (2015) found to have positive influence among GDP and CO_2 emissions. Energy consumption is required for economic growth where CO_2 emissions are a direct by-product of such energy consumption. Azlina, Law and Mustapha (2014) found of that the result showed the real income which is GDP is positive related on CO_2 emissions in Malaysia, where suggesting that 1% rise in income is associated with 2.56% rise in CO_2 emissions. If Malaysia wishes to reduce in CO_2 emission, it may cause a negative effect on economic growth. The energy consumed due to production is expected the increase of pollutant level. Therefore, Malaysia needs to improve the efficiency in other sectors for example industrial, transportation and services sector that have a close relation with the environmental degradation level.

4.5.2 Does carbon dioxide granger cause GDP?

Table 4.20 Estimated long run coefficient of ARDL approach (Cardon dioxide granger cause GDP in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNCO2	3.100217	0.670446	4.624112(0.0002)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from table 4.20 showed that the CO_2 have positive significant relationship with GDP in Malaysia in long run. The coefficient of CO_2 is significant with p-value 0.0002 at significance level of 1%, 5% and 10% for k=1. For every 1% increase in CO_2 emissions, the GDP growth will increase 3.10% on average.

Table 4.21 Estimated short run coefficient of ARDL approach (Cardon dioxide granger cause GDP in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNCO2)	26.409109	10.352430	2.551006(0.0207)**
ECT_{t-1}	-0.907626	0.261480	-3.471107(0.0029)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.21 showed that CO_2 have positive significant relationship with GDP in Malaysia in short run. The coefficient of CO_2 is significant with p-value 0.0207 at significance level of 1%, 5% and 10% for k=1. For every 1% increase in CO_2 emissions, the GDP per capita will increase 26.41% on average.

Al-mulali (2014) showed that 19 out of 30 countries have a positive relationship between GDP growth and CO_2 emissions, whereas for CO_2 emissions model, the result showed positive bidirectional short run causal relationship between GDP growth and CO_2 emissions. However, the author has found a connection between energy consumption, CO_2 emission and GDP growth. The connection indicated that if energy consumption has a positive relationship with GDP growth in a developed country, then it will have positive long run relationship with CO_2 emissions. Since most developed countries are still rely on fossil fuels to achieve their economic growth, thus energy consumption increases GDP growth which known as an important measure to the countries' standard living, it will increase the country's energy consumption which generally comes from fossil fuel that are major the sources of pollution. Therefore, energy consumption will increase CO_2 emission when it has positive relationship with GDP growth.

Boopen and Vinesh (2011) analyzed the relationship among CO_2 emissions and GDP growth for Mauritius, realized that CO_2 path is related to the GDP time path. The result showed that the emissions elasticity on GDP has been increasing time to time. Virtually all countries that experience economic growth also showed the rising of CO_2 emissions as energy consumption is needed for production. Therefore, both CO_2 emissions and GDP are closely related to each other.

Dinda and Coondoo (2006) stated there is feedback effect between GDP and CO_2 emissions as the variables are directly affecting each other. The main reason is due to the increase in production that directly increases the CO_2 emissions may cause the GDP to increases as well. Therefore, both GDP and CO_2 are closely related and will affect each other in long run and short run. Azlina, Law and Mustapha (2014) do not encourage Malaysia to immolate the economic growth due to the pollutant emissions as the reducing of CO_2 will bring consequences to economic growth. Thus, Malaysia needs to improve the efficiency level in industrial, transportation and services sector instead of only in energy sector.

As a conclusion, the relationship between GDP and CO_2 is positive bidirectional causal relationship in long run and short run. Both variables are closely related.

4.6 The relationship between GDP in Agriculture and Renewable Energy in Malaysia

4.6.1 Does renewable energy granger cause GDP in agriculture?

Table 4.22 Estimated long run coefficient of ARDL approach (renewable energy granger cause GDP in agriculture in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNRE	3.491253	0.808443	4.318490(0.0015)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from Table 4.22 illustrated that GDP in agriculture have significant relationship with the renewable energy in long run coefficient of ARDL approach in Malaysia. The coefficient of LNRE is significant with p-value 0.0015 at significance level of 1%, 5% and 10% for k=1. The GDP in agriculture is predicted to increase by 0.0349 for each additional production of renewable energy. The result showed that there is positive relationship between GDP in agriculture and renewable energy. Bayrakci and Kocar (2012) found that the changes of agricultural products' production rate used renewable energies in agriculture. It showed that there is positive relationship between GDP in agriculture and renewable energy. Reducing production costs, energy saving and improve product quality by using renewable energies. Agricultural activities need renewable energy to improve production. Besides that, biogas is one of the useful resources of renewable energies. It is used to collect and control organic wastes, produce fertilizer to use in agricultural irrigation. Farmers also can provide land for wind or solar power generation to minimize the use of fossil fuels without reduced production of agriculture (Horowitz & Gottlieb, 2010).

Sebri and Abid (2012) found out that renewable energy consumption will cause the agricultural value add in long run. The increase of energy consumptions prices or increase in the fuel taxes that will not encourage the farmers or producers to increase agricultural production and activities by using the non-renewable energy. Liu, McConkey, Huffman, Smith, MacGregor, Yemshanov and Kulshreshtha (2014) stated that increasing in demand of agriculture production resulting by the amount of energy to be produced from renewable sources. The production of renewable energy is significant to the agriculture production.

Table 4.23 Estimated short run coefficient of ARDL approach (renewable energy granger cause GDP in agriculture in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNRE)	0.748493	0.302697	2.472749 (0.0329)**
D(LNRE(-1))	-2.032262	0.509148	-3.991495 (0.0026)***
D(LNRE(-2))	-1.876992	0.462891	-4.054931 (0.0023)***
D(LNRE(-3))	-1.139560	0.526356	-2.164999 (0.0556)*
ECT_{t-1}	-0.732450	0.163125	-4.490103 (0.0012)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from Table 4.23 illustrated that GDP in agriculture have significant relationship with renewable energy in short run coefficient of ARDL approach in Malaysia. The coefficient of D (LNRE) is significant with p-value 0.0329 at significance level of 5% and 10%. The coefficient of D(LNRE(-1)) and D(LNRE(-2)) are significant with p-value 0.0026 and 0.0023 respectively at significance level 5% and 10%. The coefficient of D(LNRE(-3)) is not significant at significance level 10% but significant at significance level 10% with p-value 0.0556. The coefficient of ECT_{t-1} is statistically significant at significance level 5% and 10% with p-value 0.0012 and the theoretical expected sign is negative. The coefficients of ECT of -0.732450 indicated that 73.25% of the disequilibrium adjusted towards long run relationship in each year. According to Bayrakci and Kocar (2012), the production of biomass energy is related to the production in agriculture. Before using biomass energy in agriculture, they have to collect the biomass resources production with highest efficiency during a year.

Sebri and Abid (2012) stated that government reinforces the subsidies of setting up of renewable energy price allocated to agriculture activities to improve the infrastructure that would be suitable for this energy. This may influence the agricultural activities and productions in short run. High level of renewable energy consumptions is required to increase the agriculture sector growth. The government is more focus on the efficiency of the renewable energy to agriculture production, and reduce the reliability of fossil energy on agricultural activities and production so that agriculture sector can be sustainable. But government funding of biogas development project reduced because of lack of funding for maintenances and implementation of biogas technologies due to the shortage of renewable energy raw materials and other economic challenges (Mohammed, Mokhtar, Bashir & Saidur, 2013).

Mohammed et al. (2013) found that increasing in global concern to reduce environmental hazards and widened the renewable energy development can reduce the consumption of fossil fuels. At the same time, the renewable energy consumption and agriculture residues increase significantly at the initial period. There is cumulative emission increases in the agriculture sector over a period of time. This causes the increases of the prices of agriculture products which under renewable energy scenario initially (White, Latte, Alig, Skog & Adams, 2013).

4.6.2 Does GDP in agriculture granger cause renewable energy?

Table 4.24 Estimated long run coefficient of ARDL approach (GDP in agriculture granger cause renewable energy in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNAGR	0.811342	0.048297	16.798968(0.0000)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from Table 4.24 showed that renewable energy has significant relationship with GDP in agriculture in long run coefficient of ARDL approach in Malaysia. Sebri and Abid (2012) found that there are long run causal relationship between GDP in agriculture and renewable energy. It has positive impact between the renewable energy and GDP in agriculture. Besides that, the production wastes of agriculture can produce into renewable energy productions, for example, bioelectricity and biofuel. The residues from agriculture production can produce renewable energy productions at low cost. White et al. (2013) stressed that current and expected future technologies create opportunities to produce bio-energy from a variety of agriculture.

Koirala and Khanal (2013) illustrated increase in production of GDP in agriculture may increase renewable consumption. To increase the production of GDP in agriculture, the agriculture sector may spend more petroleum or natural gas to function the machines. Agriculture sector prefer to use renewable energy to increase the production of agriculture, due to increasing in price of petroleum.

Table 4.25 Estimated short run coefficient of ARDL approach (GDP in agriculture granger cause renewable energy in Malaysia)

Variable	Coefficient	Std.Error	t-statistic (p-value)
D(LNAGR)	0.080169	0.109606	0.731435(0.4758)
ECT_{t-1}	-0.224038	0.069853	-3.207271(0.0059)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Based on Table 4.25, renewable energy has insignificant relationship with GDP in agriculture in short run. Alam, Omar, Ahmad, Siddiquei and Sallehuddin (2013) stated that there is huge production in agriculture while renewable energy production will not be able to produce enough energy to cover the total agriculture production since government in Malaysia does not invest much in renewable energy which related to agriculture.

As a conclusion, there is positive bidirectional causal relationship between renewable energy and GDP in agriculture. In short run, there is unidirectional causal relationship running from renewable energy to GDP in agriculture.

4.7 The relationship between Carbon Dioxide and GDP in Agriculture in Malaysia

4.7.1 Does GDP in agriculture granger cause carbon dioxide?

Table 4.26 Estimated long run coefficient of ARDL approach (GDP in agriculture granger cause carbon dioxide Malaysia)

Variable	Coefficient	Std.Error	t-statistic (p-value)
LNAGR	-0.401633	0.47211	-0.850717(0.4061)
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.26 shows the long run coefficient of ARDL approach between carbon dioxide and GDP in agriculture. The table shows that the carbon dioxide and GDP in agriculture have insignificant relationship in Malaysia in long run. The coefficient of LNAGR is insignificant with the p-value 0.4061 at significance level of 1%, 5% and 10% respectively for k=1.This finding is not consistent with our hypothesis.

Mohammed et al, (2013) illustrated that the agricultural sectors can produce fertilizer to use in agricultural irrigation without influencing the increment of carbon dioxide. There are a lot of organic wastes can be converted into fertilizer and used for biogas production, especially in rural areas. For example, agriculture residues and animal wastes also can use in biogas system. Normally they used waste from fruit production as biomass resources in Malaysia. The carbon dioxide emissions increase because of methane (CH_4) and nitrous oxide (N_2O)

from soils but not agricultural production (Soegaard, Jensen, Boegh, Hasager & Schelde, 2003). Bayrakci and Kocar (2012) stated that the farmers can generate energy with animal manure and their own agricultural residues in agricultural sectors by their own.

Table 4.27 Estimated short run coefficient of ARDL approach (GDP in agriculture granger cause carbon dioxide Malaysia)

Variable	Coefficient	Std.Error	t-statistic (p-value)
D(LNAGR)	-0.070021	0.169320	-0.413543(0.6841)
ECT_{t-1}	-0.216612	0.065697	-3.297160(0.0040)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.27 illustrated that the short run coefficient of ARDL approach between carbon dioxide and GDP in agriculture in Malaysia. The relationship between carbon dioxide and GDP in agriculture is insignificant. The coefficient of D(LNAGR) is insignificant with p-value 0.6841 at significant levels of 1%, 5% and 10%. Besides that, the coefficient of ECT_{t-1} is statistically significant and theoretical expected sign which is negative. The coefficient of ECT of -0.216612 indicated that 21.67% of the disequilibrium will be adjusted towards long run relationship in each year. The production of renewable energy in the agricultural sector is insignificant to the carbon dioxide in Malaysia.

Li and Zheng (2011) stated that the agricultural sectors can increases their activities and production with renewable energy production without influence the carbon dioxides emissions, but they do not apply renewable energy in agricultural sector. The reason why the renewable energy cannot apply in short run, because durable and higher maintenance fees is needed and also require higher prices to set-up the renewable energy system (Liu et al., 2014).

Bayrakci and Kocar (2012) found that it is costly to set-up the water pump system that depends on solar energy. It is expensive and maintenances are needed for every day. This is the reason of insignificant between carbon dioxide and GDP in agriculture in short run.

4.7.2 Does carbon dioxide granger cause GDP in agriculture?

Table 4.28 Estimated long run coefficient of ARDL approach (carbon dioxide granger cause GDP in agriculture in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNCO2	1.171882	0.079710	14.701751(0.0000)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from table 4.28 showed that there is significant relationship between GDP in agriculture and carbon dioxide in long run. The production in agriculture will increase when carbon dioxide production increases. Timothy (2008) stated that the increasing of production in agriculture will be affected when the higher the concentration of carbon dioxide in atmospheric. The rising level of atmospheric carbon dioxide will increase the food production directly or indirectly. The increase in concentration of atmospheric carbon dioxide enhances the plant growth and development. This is the reason why significant relationship between GDP in agriculture and carbon dioxide in long run. The changes in farming practices and improvement of technology can increase the production of agricultural although with high carbon dioxide levels.

Besides that, based on Amran, Zainuddin and Zailani (2012), the increases in carbon dioxide will affect agricultural production in Malaysia. The raising of concentration of carbon dioxide can benefit some crops. Carbon dioxide can spur the activity of agricultural crops. According to Thomas and Griffin (1994), the increases in carbon dioxide have significant effect on plant respiration. This is because the increased carbon dioxide level may increase the leaf conductance in some crops and reducing transpiration of the crops. The higher level of carbon dioxide can help the plants reducing lose water through the pores in leaves.

Table 4.29 Estimated short run coefficient of ARDL approach (carbon dioxide granger cause GDP in agriculture in Malaysia)

Variable	Coefficient	Std.Error	t-statistic (p-value)
D(LNCO2)	-0.011942	0.254437	-0.046935(0.9633)
D(LNCO2(-1))	-0.071633	0.228232	-0.313860(0.7590)
D(LNCO2(-2))	0.274946	0.228330	1.204161(0.2517)
D(LNCO2(-3))	0.659074	0.23157	2.826740(0.0153)**
ECT_{t-1}	-0.220059	0.065648	-3.352083(0.0058)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from table 4.29 illustrated that there is insignificant relationship between GDP in agriculture and carbon dioxide in short run. Soffar (2015) found that carbon dioxide will increase the temperature of the environment which is very inconvenience to humans. The increase in human population will produce more carbon dioxide. The extra carbon dioxide may cause the planet to become warmer. But that will not influence to the GDP in agriculture. Plants need water, sunlight, nitrogen, and other nutrients to grow, but carbon dioxide will not influence the needed of the plants. Water supply and sunlight will not affected by the higher level of carbon dioxide. So there is no significant relationship between the GDP in agriculture and carbon dioxide since carbon dioxide not affected the basic needs of plants.

As a conclusion, there is unidirectional causal relationship running from CO_2 to GDP in agriculture in long run, but both variables have no relationship between each other in short run.

4.8 The relationship between GDP in Manufacturing and Renewable Energy in Malaysia

4.8.1 Does renewable energy granger cause GDP in manufacturing?

Renewable energy does not have relationship with GDP in manufacturing in long run and short run. This proved that the result is not uniform with the hypothesis stated. Bujang, Bern and Brumm (2016) found that Malaysia's industries are mainly focus on coal compare to renewable energy in a production, thus there is no relationship between renewable energy and manufacturing. Next is Five-Fuel Diversification Policy was target to contribute renewable energy is 5% but actual is only 0.3%, this is because fuel price is lower than renewable energy, industry sector will consume more fuel in a production rather than generate renewable energy. Malaysia Government subsidies in fossil fuel have showed in market failure and this lead to renewable energy difficult to establish (Kardooni, Yusoff & Kari, 2016). Next, in Europe countries, the presence of nuclear power is increasing around 70% the industry sector. Thus, industry more focuses demand on nuclear power in order to produce electricity (Betzold, 2016).

The Sarawak Corridor of Renewable Energy (SCORE) highly encourage industry consume more renewable energy especially in hydropower. However, to obtain renewable energy in industry sector it requires investing huge amount and interest from other development country's entities, because the installment cost and maintenance cost of renewable energy is very high. Manufacturing sector does not have huge capital to expend on this cost (Olz & Beerepoot, 2010; Betzold, 2016). This reason is supported by Seng, Lalchand and Gladys (2008) showed that the private investment on renewable energy is reducing. This is because private sector founded that the return of investment on renewable energy is very low and lack of fund. Thus, these reason are showing that renewable energy consume by industry is negative relationship. Furthermore, Malaysia's manufacturing does not have sufficient capital to obtain renewable energy such as hydroelectric station and photovoltaic form solar energy. Some of the materials need to import from Japan, thus industry need spend the extra cost to pay the shipping fees, therefore industry sector choose not to obtain renewable energy in Malaysia. Hence, there is no relationship between renewable energy and GDP in manufacturing in Malaysia (Mustapa, Leong & Hashim, 2010).

In addition, this result support by Seetharaman, Sandanaraj, Moorthy and Saravanan(2016) proved that renewable energy is incomplete establish to satisfy industry sector because manufacturing sector which included business strategy, insufficient technology, information or experience to adopt renewable energy. Some of the regulation had restricted on industry sector to develop the renewable energy such as government. Government is restricting on the cost of barriers, the ethos of Malaysia do not want to support any cost to adopt renewable energy because the cost and benefit do not reach an equilibrium point. Gill (2005) discussed about manufacturing sector lack of the awareness and perception to use renewable energy and lack of technicians who need to maintain and install renewable energy to generate electricity power, industry could not identify the problem and have difficulty to solve the problem form using renewable energy (Hassett & Borgerson, 2009; Seng et al., 2008; Olz & Beerepoot, 2010).

4.8.2 Does GDP in manufacturing granger cause renewable energy?

Based on table 4.12, there is no co-integration between GDP in manufacturing and renewable energy in Malaysia. Renewable energy is a green technology which can improve the green environments, save energy consumption. According to the Small Renewable Energy Power programs which establish to motivate private sector to invest in the renewable energy which included biomass, solar, mini-hydroelectric and wind energy. Malaysia is the world largest country who exports the palm oil. Palm oil is abundant to provide biomass which can produce electricity and fuel (Bujang et al., 2016). However, renewable energy could not produce huge volume of product to satisfy customer needs. Thus manufacturing choose not to use renewable energy to generate production. Therefore, there is no relationship between GDP in manufacturing and renewable energy.

Besides that, renewable energy cost is slightly higher compare to energy, only high income can adopt more type of the renewable energy, but Malaysia only able to adopt more on solar and biomass because manufacturing consume more oil and coal and their price is cheaper (Bujang et al., 2016). In finance perspective, renewable energy requires large investment, large scale of production cost to set up, high capital cost and maintenance cost. Government highly encourage private sector to invest more fund on renewable energy but the result show that the return is low. Thus, there is not enough capacity to adopt renewable energy (Seng et al., 2008). Hence renewable energy is not actively use in Malaysia, but this will not affect manufacturing production.

Jess (2011) stated that renewable energy could not function well in the manufacturing sector because it needs manual system to generate the production in manufacturing. It also does not provide the good informational technology implementation such as real time monitoring and accurate data providing for the business. Hassett and Borgerson (2009); Seng et al. (2008); Olz and Beerepoot (2010) stated manufacturing employee do not increases experience to use the renewable energy, because governments do not promote public awareness about utility of renewable energy. However, manufacturing produce the production by using energy because it is more effective way to generate the production. Therefore, renewable energy will not influence the manufacturing in Malaysia performance. There is no relationship between GDP in manufacturing in Malaysia and renewable energy.

As a conclusion, there is no relationship between renewable energy and GDP in manufacturing in both long run and short run.

4.9 The relationship between Carbon Dioxide and GDP in Manufacturing in Malaysia

4.9.1 Does GDP in manufacturing granger cause carbon dioxide?

Table 4.30 Estimated long run coefficient of ARDL approach (GDP in manufacturing granger cause carbon dioxide in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNMAN	0.585216	0.036257	16.140923(0.0000)**
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

As shown in Table 4.30, carbon dioxide has positive relationship with GDP in manufacturing in long run. 1 % increases in carbon dioxide, GDP in Manufacturing will increase 0.58%. This result has proven that is uniform with the hypothesis stated. In short run, manufacturing in Malaysia was adopt Kyoto protocol to control carbon dioxide, cleaning technology to purify the carbon dioxide, but when come to long run, carbon dioxide emission increases because the economy is growing rapidly, those technology could help much to control the carbon dioxide emission. The maintenance cost is high, manufacturing could not support in long run it only can last for short period. Nerveless, manufacturing in Malaysia increases in long run, air pollution will be increase as well. Begum et al. (2015) stated that manufacturing have positive effect on carbon dioxide emission. Grossman and Krueger (1995); Gan and Li (2008); Ang (2008); Azlina and Mustapha (2008) proved that industry sector increases will affect the carbon dioxide emission increases. The reason is because in year 1970 to 1980 economic growth in Malaysia is rapidly increases and industry sector also will expand as well. Manufacturing sector will consuming more energy in a production, thus this will affect the increases the air pollution in environment.

With the exportation of Malaysia's manufacturing product, industry may also increases the efficient of production and benefit from duty free import of raw resource, free tax and duties which can reduce the production cost. Thus it result that manufacturing increases because of low production cost and it may leading to increases the carbon dioxide emission (Wu, Pineau & Caporossi, 2010; Sueyoshi & Goto, 2011). Next is the researcher, Ramli and Munisamy (2015); Ang (2007); Soytas and Sari (2007), Menyah and Wolde (2010) showed that manufacturing in Malaysia carry out the efficiency process to generate an output may affect the environment, which mean that air pollution in long run will increases.

Shahbaz, Loganathan, Zeshan and Zaman (2015) stated that, fossil fuel consumption and electricity production, advance technology transformations in industry sector will lead to increases the carbon dioxide emission to atmosphere. Developing country had revolution from agricultural to manufacturing activity and privatization could lead to increases the carbon dioxide emission (Shahbaz, Loganathan, Muzaffar, Ahmed & Jabran, 2016; Schmidt, 2009). From Nakamichi, Hanaoka and Kawahara (2016) studies stated that Cambodia's industries mainly focus on electricity emission factor and the production had been increases, this will affect carbon dioxide will have positive relationship with industry sector. In Asia, industry sector in automobile have expand and developing, thus will implication large the carbon dioxide emission.

Moreover industry is value added, people demand on irons, steel and cement defiantly increases, this will leading to Malaysia export increases, and industry will increase the effectiveness in a production. Hence air pollution in environment will increase (Burke et al., 2015). OECD and high income countries' manufacturing have high technologies which require fuel combustion and it will affect carbon dioxide emission increases. Low income countries do not have sufficient cost to adopt renewable energy technology to reduce carbon dioxide emission (Mamun, Sohag, Mia, Uddin & Ozturk, 2014). OECD and high income countries' manufacturing adopt renewable energy to build up the production and reduce pollution in environment, but due to the maintenance cost is very high, manufacturing could not support to maintenance fees. Therefore, the industries choose to consume energy in a production and this may cause environment degradation (Olz & Beerepoot, 2010; Betzold, 2016).

<u>Table 4.31 Estimated short run coefficient of ARDL approach (GDP in manufacturing granger cause carbon dioxide in Malaysia)</u>

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNMAN)	-0.686239	0.043372	-1.547771 (0.0391)
ECT_{t-1}	-0.203651	0.054773	-3.718102(0.0016)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Table 4.31 shows that, carbon dioxide have insignificant relationship with GDP in manufacturing in short run. The coefficient of LNAGR is insignificant with the p-value 0.0391at significance level of 5% and 10% respectively for k=1.

Bekhet andYasim (2013) stated that Malaysia’s industries sector had adopt the Kyotol protocol to control the carbon dioxide emission in short run. Kyotol protocol is the first agreement between countries which require balancing the carbon dioxide emission. Malaysia adopts this technology to enhance the green environment and trying to control the carbon dioxide to maximum. The reason is because Malaysia is a developing country, economy is slowly growth, and manufacturing is a major sector that contributes to increase the GDP. Therefore, manufacturing need to consume more energy to produce large production to fulfill the population needs which will lead to carbon dioxide increase. Hence, Malaysia adopts Kyotol protocol to control the carbon dioxide. At the end, there increases the manufacturing production will not affect increasing or decreasing of carbon dioxide.

Tridech and Cheng (2011); Chryssolouris (2013) examined that Low carbon manufacturing will not affect carbon dioxide emission. The reason is because manufacturing fully utilize the resources and produce low carbon emission during the production. Manufacturing is using the low carbon energy such as, low fossil fuel and low coal to generate a product which can control the carbon dioxide emission from manufacturing sector. Feng and Zou (2008) claimed that in China, Manufacturing upgrading energy efficient and energy structure to control carbon dioxide emission.

Moutinho, Robaina-Alves and Mota (2014) proved that manufacturing have adopt the cleaner technology in order to control carbon dioxide.

When the manufacturing release the carbon dioxide, the cleaner technology will filter the carbon dioxide before it release into atmosphere. Thus, manufacturing activities will have no effect on carbon dioxide. In addition, manufacturing also uses more electrical power to generate the machine to process the production and reducing use fossil fuel or coal to generate the production in the short run. As a result, there is no relationship between carbon dioxide and manufacturing.

4.9.2 Does carbon dioxide granger cause GDP in manufacturing?

Based on table 4.12, there is no co-integration between carbon dioxide and GDP in manufacturing in short run and long run. In another words means, carbon dioxide emission increases or decreases will not affect GDP in manufacturing. This is because factor affect carbon dioxide emission is major from deforestation which will lead to global climates. For example, to cut off the trees in the forest to consume the fuel wood will generate carbon dioxide emission and these activities will cause the inflaming in global warming (Malhi, Roberts, Betts, Killeen, Li & Nobre, 2008). Although carbon dioxide emission increases, but GDP in manufacturing will still continues to operate. Hence, the increase in carbon dioxide emission will not influence GDP in manufacturing production but it could lead to global warming.

As a conclusion, there is unidirectional causal relationship running from GDP in manufacturing to CO2 in long run but there is no causal relationship in short run.

4.10 The relationship between GDP in Services and Renewable Energy in Malaysia

4.10.1 Does renewable energy granger cause GDP in services?

Table 4.32 Estimated long run coefficient of ARDL approach (renewable energy granger cause GDP in services in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNRE	0.510812	0.166370	3.070346(0.0073)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Based on the result in table 4.32, there is apositive relationship between the GDP in services and renewable energy in Malaysia. When there is 1% increase in the renewable energy, will in increase 0.51% for Malaysia's GDP in services sector in long run. This result is consistent with the previous studies in Malaysia from the researchers (Tye, Lee, Wan Abdullah & Leh, 2011). Malaysia is one of the countries that full of nature fossil fuel. While, transportation sector are the main sector that utilising the total usage of 40.3% energy in Malaysia. They found that countries will be suffered from lack of energy or fossil fuel after the year of 30 to 40. It is to estimate that if the energy strategy do not change, Malaysia GDP and economic will switch downturn. It indirectly prove there is a significant between the renewable energy and GDP in Malaysia. So that, the Prime Minister of Malaysia decided to promote biodiesel as a new energy fuel for transportation in Malaysia to reduce the usage of fossil fuel.

Nowadays, a lot of tourism selects renewable energy accommodation as their priority. Dalton, Lockington and Baldock (2008) found that Australian tourists willing to pay a specific amount to stay under a renewable energy accommodation during their trip. This will show there is an significant when there are more hotels install renewable energy, the more the tourism will be attracted (Tsagarakis, Bounialetou, Gillas, Profylienou, Pollaki & Zografakis, 2011; Dalton et al., 2008).

Table 4.33 Estimated short run coefficient of ARDL approach (renewable energy granger cause GDP in services in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNRE)	0.048591	0.111576	0.435495(0.6690)
ECT_{t-1}	-0.724041	0.172380	-4.200254(0.0007)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Result from table 4.33 illustrated that there is insignificant relationship in short run between GDP in services and renewable energy in Malaysia. No matter how increase or decrease in renewable energy, there is still no affect on GDP in services. Renewable energy is costly in short run and not well developed, companies and investor will invest less to avoid losses. So there will be not much affect on services GDP. The another reason may be at the beginning of the year, Malaysia government do not invest much renewable energy. As the renewable energy involve in the high cost of instalment and maintenance fee, and the technology of renewable energy is still not mature.

4.10.2 Does GDP in services granger cause renewable energy?

Table 4.34 Estimated long run coefficient of ARDL approach (Does GDP in services granger cause renewable energy in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNSER	0.459071	0.057602	7.969671(0.0000)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

Based on table 4.34, there is a positive relationship between the renewable energy and GDP in services in Malaysia. When there is 1% increase in GDP in services, there will be increase 0.45% in renewable energy in long run. In year 2014, Malaysia Prime Minister Najib Razak has announced, that Malaysia government will not going to subsidies the petrol to Malaysia citizens. If the market oil price increase, the retail price of fossil fuel (petrol) will increase as well, and vice versa. However, logistic is one of the business sectors to grow the Malaysia economic. It requires a huge amount of fossil fuel to conduct their logistic business. In order to reduce the higher cost of fossil fuel, many logistic companies have decided to implement renewable energy (Salehudim, Prasad, & Osmond, 2011).

Tourism represents an important economic driver for Mediterranean island. Mediterranean islands is one of the state in European Union country, there are more than 30% of revenue comes from tourism sector (Dascalaki & Balaras, 2004). Nowadays, Mediterranean island is facing a problem which is come from the tourist. As when there is increase the rate of tourism arrivals, the island will face a insufficiency of electricity transport interconnections as there is a high cost of energy feeding (Michalena, 2008). Since the island facilities (water heating, lighting, and air condition transportation) are produces by diesel generators. Therefore, the Europe government had decided to install renewable energy to reduce their cost of energy. They found that, implement renewable energy in the island not only can reduce the higher cost of energy, it may also keep their island environment clean and fresh. However, stakeholders may gain from deployment of renewable technology. In private sector, as when there is declining in electricity bill from tourism sector, their profit would be increase in both suppliers and utilities. While in government sector, implement renewable energy may create more opportunity of employment to their citizen, and also improve the environmental quality in the island.

Table 4.35 Estimated short run coefficient of ARDL approach (Does GDP in services granger cause renewable energy in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNSER)	-0.028578	0.314586	-0.090843(0.9286)
ECT_{t-1}	-0.091526	0.025930	-3.529749(0.0022)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1.			

In short run based on table 4.35, there is no relationship between the GDP in services and renewable energy in Malaysia. It may be the reasons of less investor invest in the renewable energy because they are still lack of the knowledge about renewable energy. Therefore, the government does not invest much in renewable energy, because they do worry whether they can cover the cost of implementing and the maintenance fee of renewable energy.

As a conclusion, there is positive bidirectional relationship between renewable energy and GDP in services in long run but there is no causal relationship in short run.

4.11 The relationship between carbon dioxide and GDP in services in Malaysia

4.11.1 Does GDP in services granger cause carbon dioxide?

Table 4.36 Estimated long run coefficient of ARDL approach (GDP in services granger cause carbon dioxide in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
LNSER	2.508353	1.752528	1.431277(0.1695)
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1			

Table 4.37 Estimated short run coefficient of ARDL approach (GDP in services granger cause carbon dioxide in Malaysia)

Variable	Coefficient	Std. Error	t-statistic (p-value)
D(LNSER)	0.293080	0.449253	0.652371(0.5224)
ECT_{t-1}	-0.236106	0.061724	-3.825165(0.0012)***
Remarks: ***, ** and * referring to the rejection of null hypothesis at significance level 1%, 5% and 10% respectively for k=1			

Based on the result in table 4.36 and table 4.37, there is insignificant relationship in both long run and short run between carbon dioxide (CO_2) and GDP in services in Malaysia. The result is not consistent with the previous studies from the researchers. Tourism is one of the major sector in Malaysia services sector, the result show that, when there is increasing tourism in Malaysia, it could not affect the carbon dioxide (CO_2) increase. It may be because of using renewable energy could help to control the environment which will not be affect the CO_2 increase. Perhentian Island is one of the popular islands in Malaysia. In year 2007, Malaysia federal government developed a renewable energy project by installed 2 wind turbines, photovoltaic panels, batteries and generator to provide a clean and reliable source of energy for tourism facilities like hotel air-condition, water heater, and so on (Salahuddin & Gow, 2014). It indirectly improves the Malaysia services' GDP, and also will not generate CO_2 to damage the environment.

Another example in Dubai, their GDP in services increase doesn't affect their CO_2 increase in the country. It is because they are strongly implement renewable energy in Dubai, to avoid environment pollution.

Dubai government encourage the hotel sector to be conscious about to use more natural resources and reduce the non-renewable energy consumption (electric, water heater, and so on) and also implement the system which can reduce the CO_2 emission. They are very concern with their country environment, and implement few plan to protect their country to be affected by CO_2, to attract more tourism to Dubai, by increase their GDP (Khawaja, 2012). However, it prove that, even their tourism GDP increase also will not cause the CO_2 emission increase in their country.

4.11.2 Does carbon dioxide granger cause GDP in services?

Based on table 4.13, there is no co-integration between the relationship of GDP in services and CO_2 in Malaysia. CO_2 increase or decrease will not affect the GDP in services. Kuala Lumpur is the big city in Malaysia, it is one of the popular city that attract a lot of tourism. Increase in CO_2 doesn't affect the tourist comes to Malaysia, it is because Malaysia is a country without four season, a lot of tourist from China and Euro country will choose to visit Malaysia during the summer season.

No matter there is increase or decrease of CO_2, the logistic company will still keep on going with their business. Since the CO_2 will not affect their business, they will not stop their transportation business which would not affect their business. However, some of the transportation businessmen, they were implement the renewable energy to replace the fossil fuel, which will not generate the CO_2 and also reduce the cost of high cost fossil fuel.

As a conclusion, there is no causal relationship between GDP in services and CO_2 in long run and short run.

4.12 Conclusion

Based on the eight CUCUM test, it show the results in Malaysia was stable, as the cumulative sum is stay in the area between the two critical lines. Which mean the CUSUM of square is stable at the 5% of significant level.

CHAPTER 5: DICUSSION, CONCLUSION AND IMPLICATION

5.0 Summary and Conclusion

The main concern of global warming is caused by the rapid increase of carbon dioxide. Therefore, the renewable energy need to be used and manage efficiently to reduce the emissions of CO_2. Renewable energy included energy generated from solar, wood, wind, geothermal, waste and biomass. Renewable energy is clean and inexhaustible if compared to conventional energy. This study examines the relationship between GDP by sector in agriculture, manufacturing and services, renewable energy and CO_2 emissions.

This result shows that the causal relationship between GDP and renewable energy are co-integrated, there is unidirectional causal relationship running from renewable energy to GDP in long run which consistent with the growth hypothesis, but there is unidirectional causal relationship running from GDP to renewable energy in short run, which consistent with the conservative hypothesis. Besides, based on the result, there is positive bidirectional causal relationship between GDP and CO_2 emissions in both long run and short run as both results are positive significant, which consistent with the feedback hypothesis results.

This result show there is bidirectional relationship in long run, which is positive bidirectional causal relationship between GDP in agriculture and renewable energy which consistent with the feedback hypothesis but unidirectional causal relationship running from renewable energy to GDP in agriculture in short run which consistent with the growth hypothesis. Moreover, this study found that CO_2 emissions and GDP in agriculture is unidirectional causal relationship running from CO_2 emissions to GDP in agriculture in long run which consistent with the growth hypothesis. Whereas for short run, the result consistent with the neutral hypothesis which both variables have no impact to each other.

For GDP in manufacturing and renewable energy, both are not co-integrated which means the two variables will not affect to each other in long run and short run which consistent with the neutrality hypothesis. In addition, the result shows there is unidirectional causal relationship running from GDP in manufacturing to CO2 emissions in long run which consistent with the conservative hypothesis but there are no impact in the short run, which consistent with the neutrality hypothesis.

For the variables of GDP in services and renewable energy, the result is consistent with the feedback hypothesis in long run which is positive bidirectional causal relationship between the variables, but in short run, there is consistent with the neutrality hypothesis, which means both variables will not affect each other in short run. Furthermore, this study shows that there is no causal relationship between GDP in services and CO_2 emissions in long run and short run which consistent with the neutrality hypothesis.

5.1 Policy implication

This study focuses on the relationship between renewable energy, carbon dioxide and GDP in three different sectors (agriculture, manufacturing and services). This study is to provide useful information for government, policy maker, and public investors.

According to the results, there is a positive relationship between renewable energy and GDP in services. Malaysia may try to develop renewable energy sector such as Scandinavia and Germany with windmill project. It can use to generate electricity and also to attract more tourists to Malaysia, which will directly increase the GDP in services. By doing so, government may try to present policy plan to attract more private sectors to invest in this project, since the project may bring a lot of benefit and profit to both private sector and government sector.

There is no relationship between manufacturing in Malaysia and renewable energy. Government should implement practical policy such as feed-in-tariff, which is long term agreement and pricing guarantee for energy production while in financial perspective is to encourage private sectors to invest more on renewable energy to maximum the energy resources and increases green environment thus it can increase the economic growth in Malaysia. Government encourages manufacturing to adopt renewable energy because it can improve the effectiveness of using the renewable energy resources and increase the contribution of renewable energy in Malaysia. By doing this, it can increase the public awareness about the advantage of renewable energy and important of clean environment in Malaysia.

Even though the result showed GDP in agriculture will not affect the CO_2, but in order to prevent CO_2 to increase in the future, government should develop plans to encourage farmers to use the renewable energy. As there are many farmers worry that they could not afford to purchase renewable energy machinery, government may come out with a strategy to benefit private sector or investor who are willing to invest in renewable energy technologies and rent it to farmers at a lower cost. Companies who provide renewable energy should receive a tax deduction on their profit making. While on the other side, farmers will also receive benefit from cheaper electricity bill by using renewable energy. Besides that, government may support farmers by appointing professional technician by teaching those farmers to using the renewable energy machine, since those farmers are lack of educated on using this high tech machinery, while solar energy are a good example of it.

5.2 Limitations

There are some limitations in this study and one of the limitations is limited data available. Year 1990 until year 2011 is chosen because the data is only available for this time period. There is only annual time series data in Malaysia available. This is because renewable energy is not really considered as a main source of energy before 1990s in Malaysia. Thus, there is no data available before this time period.

Besides that, this study was conducted based on a single country (case study) using time series analysis. There is lack of prior research because there is only one country involved in this study. Besides that, there is less studies which discuss renewable energy production and the effects of renewable energy applied in Malaysia. This is because Malaysia have relative short period of time in applying renewable energy. The analysis will contribute new knowledge if ASEAN countries are added to the subject.

Lastly, this study examines the interaction between renewable energy, as well as their relationship with GDP by sector. The scope of the study can be discussed only between renewable energy, GDP by sector and carbon dioxide. The relationship between the sources of renewable energy and GDP by sector is not examined.

5.3 Recommendation

While Malaysia energy sector is still depending on fossil-based energy such as fossil fuels and natural gas. There is a possibility that in future renewable energy can be expanded into the main energy consumption.

This study was conducted based on a single country (case study) using time series analysis. One of the recommendations to future researcher is to enhance the study by investigating more countries in a panel framework.

The study can also include variables such as geographical location, energy intensive industries and interconnected electricity system. This will provide future researchers to form a different view point on the relationship between renewable energy and GDP by sectors in other countries.

Furthermore, this study also suggests that future researchers to examine the interaction between the sources of renewable energy, as well as their relationship with GDP by sector. This will provide future researchers to form a different view point on the relationship between diversification of renewable energy sources and GDP by sectors. By doing so, policy makers could develop several specific ways to implement new law and policy which could have reduced the CO_2 emission.

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Appendices

Appendix 1: Augmented Dickey-Fuller Test

Level Form: Trend and Intercept

GDP

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.371120	0.0122
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

GDP in Agriculture

Null Hypothesis: AGR has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.895680	0.9377
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

GDP in Manufacturing

Null Hypothesis: MAN has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.260782	0.8696
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

GDP in Services

Null Hypothesis: SER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.255671	0.4376
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Carbon dioxide

Null Hypothesis: CO2 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.740913	0.2318
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

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

Renewable Energy

Null Hypothesis: RE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.349258	0.9818
Test critical values:	1% level	-4.532598	
	5% level	-3.673616	
	10% level	-3.277364	

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

First Different: Intercept

GDP

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.215626	0.0001
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

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

GDP in Agriculture

Null Hypothesis: D(AGR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.972404	0.0075
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

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

GDP in Manufacturing

Null Hypothesis: D(MAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.844885	0.0093
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

GDP in Services

Null Hypothesis: D(SER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.881841	0.0010
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Carbon Dioxide

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.040995	0.0007
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Renewable Energy

Null Hypothesis: D(RE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=3)

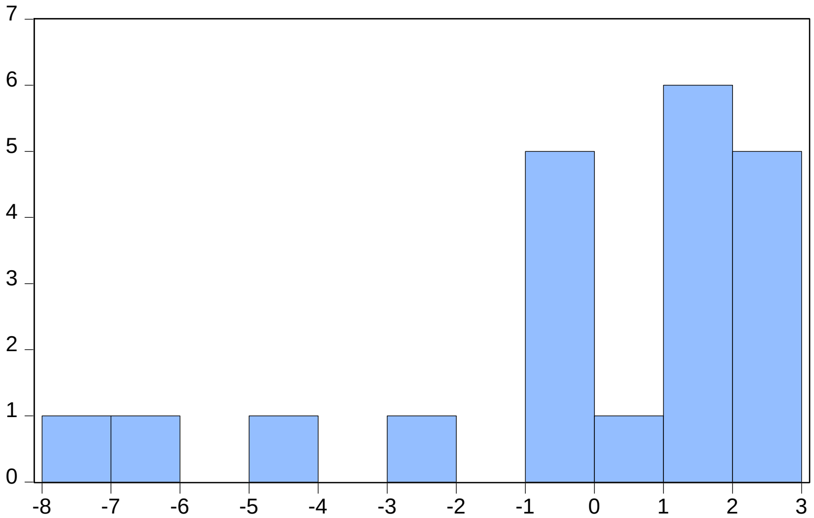
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.960730	0.0561
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

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

Appendix 2: Result of Diagnostic Checking

GDP and Renewable Energy

JarqueBera Normality Test



Series: Residuals
Sample 1991 2011
Observations 21

Mean	-7.11e-15
Median	1.092310
Maximum	2.999129
Minimum	-7.533078
Std. Dev.	3.040352
Skewness	-1.305374
Kurtosis	3.793439
Jarque-Bera	6.514857
Probability	0.038487

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.498872	Prob. F(2,14)	0.6176
Obs*R-squared	1.397051	Prob. Chi-Square(2)	0.4973

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.411318	Prob. F(1,18)	0.5294
Obs*R-squared	0.446810	Prob. Chi-Square(1)	0.5039

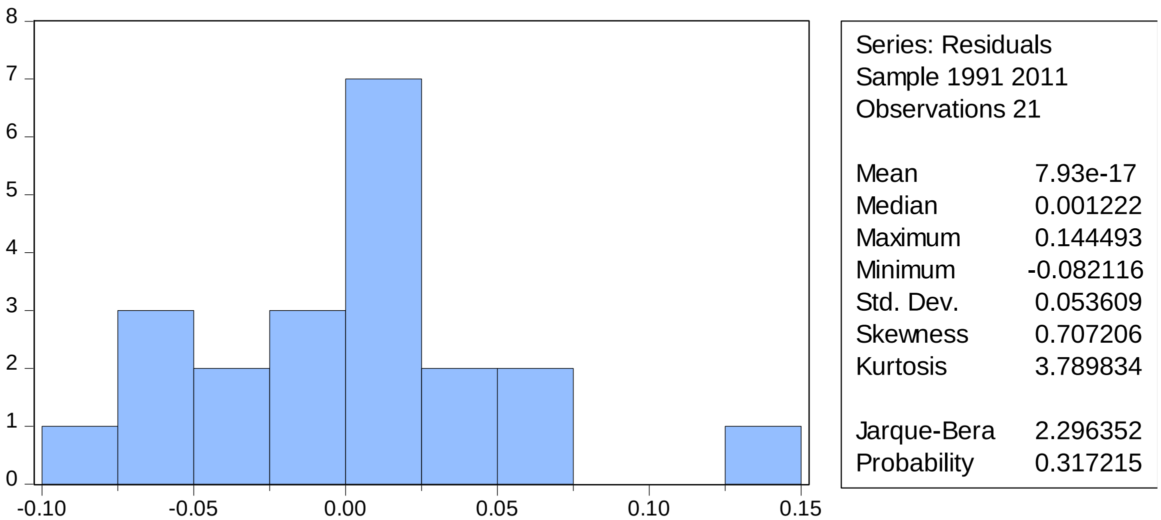
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: GDP GDP(-1) LNRE LNRE(-1) C @TREND
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.702625	15	0.1093
F-statistic	2.898930	(1, 15)	0.1093

CO2 and GDP

JarqueBera Normality Test



Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.859445	Prob. F(2,14)	0.1922
Obs*R-squared	4.407539	Prob. Chi-Square(2)	0.1104

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.007476	Prob. F(1,18)	0.9321
Obs*R-squared	0.008304	Prob. Chi-Square(1)	0.9274

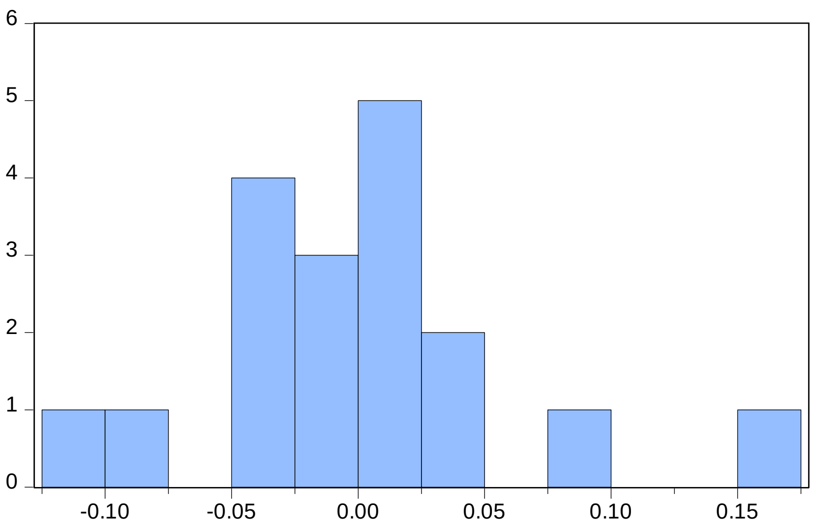
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNCO2(-1) GDP GDP(-1) C @TREND
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.646720	15	0.1204
F-statistic	2.711687	(1, 15)	0.1204

GDP in agriculture and Renewable Energy

JarqueBera Normality Test



Series: Residuals	
Sample 1994 2011	
Observations 18	
Mean	2.42e-16
Median	-0.006764
Maximum	0.159589
Minimum	-0.115756
Std. Dev.	0.061007
Skewness	0.783377
Kurtosis	4.367142
Jarque-Bera	3.242848
Probability	0.197617

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.230502	Prob. F(4,6)	0.9115
Obs*R-squared	2.397592	Prob. Chi-Square(4)	0.6631

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.992824	Prob. F(4,9)	0.4590
Obs*R-squared	4.286245	Prob. Chi-Square(4)	0.3687

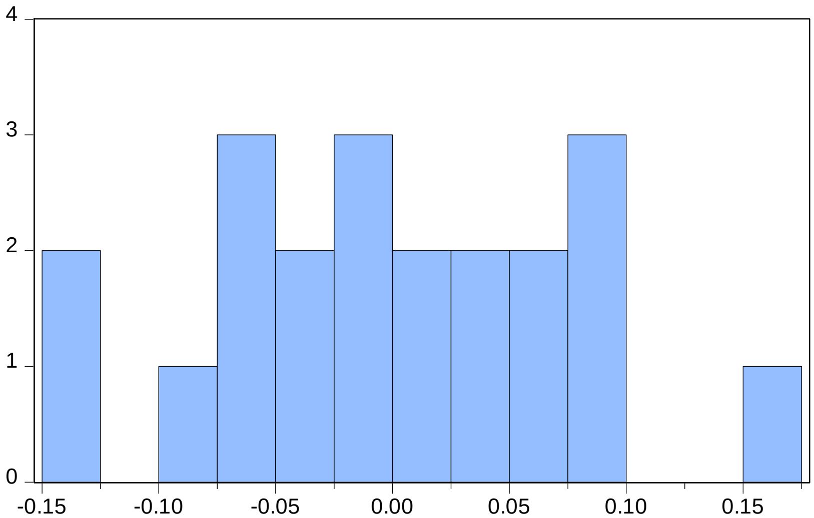
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNAGR LNAGR(-1) LNRE LNRE(-1) LNRE(-2) LNRE(-3) LNRE(-4) C @TREND
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.870034	9	0.4069
F-statistic	0.756959	(1, 9)	0.4069

CO2 and GDP in agriculture

JarqueBera Normality Test



Series: Residuals
Sample 1991 2011
Observations 21

Mean	-1.57e-17
Median	-0.001047
Maximum	0.161309
Minimum	-0.142291
Std. Dev.	0.078807
Skewness	0.025309
Kurtosis	2.413463
Jarque-Bera	0.303265
Probability	0.859304

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.106689	Prob. F(2,16)	0.8994
Obs*R-squared	0.276372	Prob. Chi-Square(2)	0.8709

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.014618	Prob. F(1,18)	0.9051
Obs*R-squared	0.016229	Prob. Chi-Square(1)	0.8986

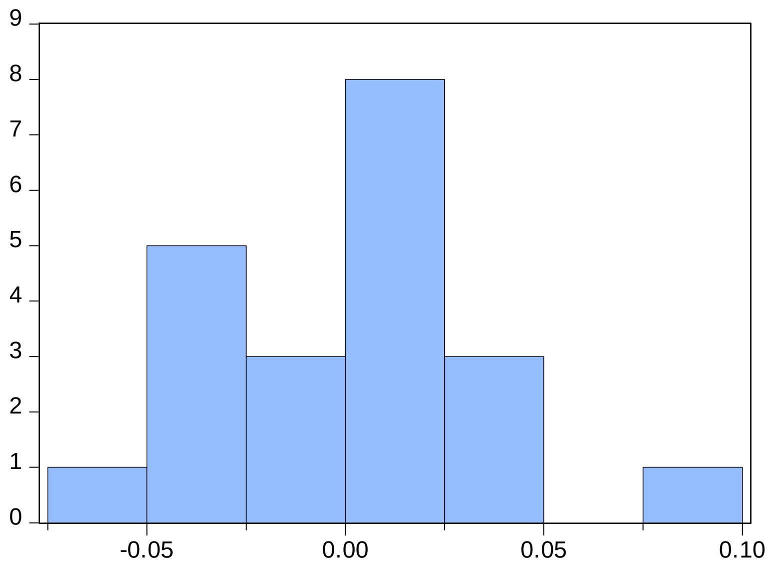
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNCO2(-1) LNAGR C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.883607	17	0.3892
F-statistic	0.780761	(1, 17)	0.3892

GDP in manufacturing and Renewable Energy

JarqueBera Normality Test



Series: Residuals
Sample 1991 2011
Observations 21

Mean	2.02e-16
Median	0.006591
Maximum	0.077303
Minimum	-0.071257
Std. Dev.	0.034192
Skewness	0.045706
Kurtosis	2.898301
Jarque-Bera	0.016361
Probability	0.991853

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.002219	Prob. F(1,16)	0.9630
Obs*R-squared	0.002913	Prob. Chi-Square(1)	0.9570

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.649462	Prob. F(1,18)	0.4308
Obs*R-squared	0.696494	Prob. Chi-Square(1)	0.4040

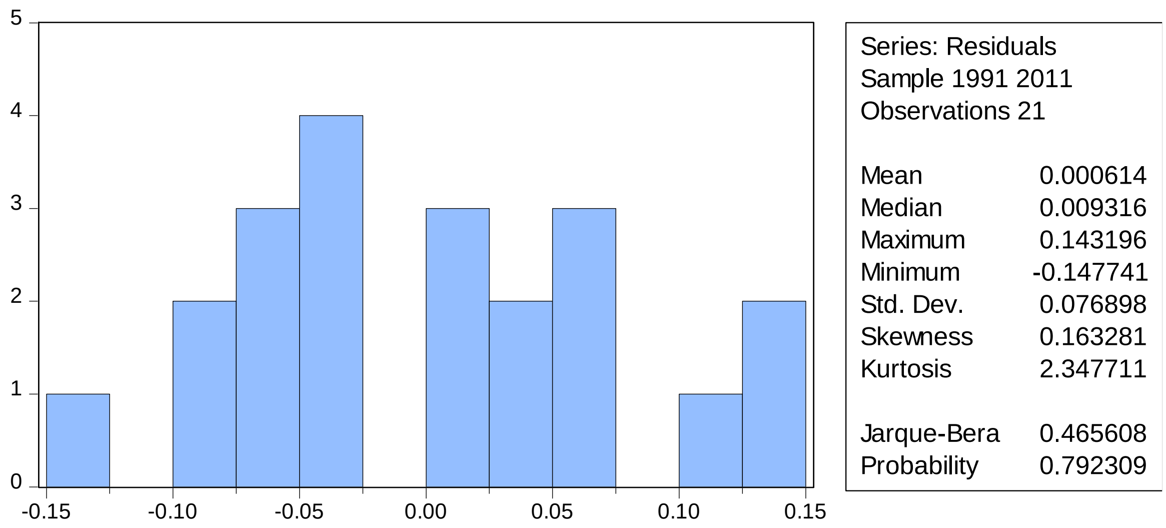
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNMAN LNMAN(-1) LNRE C @TREND
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.864002	16	0.4004
F-statistic	0.746499	(1, 16)	0.4004

CO2 and GDP in manufacturing

JarqueBera Normality Test



Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.040680	Prob. F(2,16)	0.9602
Obs*R-squared	0.106244	Prob. Chi-Square(2)	0.9483

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.522049	Prob. F(1,18)	0.4793
Obs*R-squared	0.563705	Prob. Chi-Square(1)	0.4528

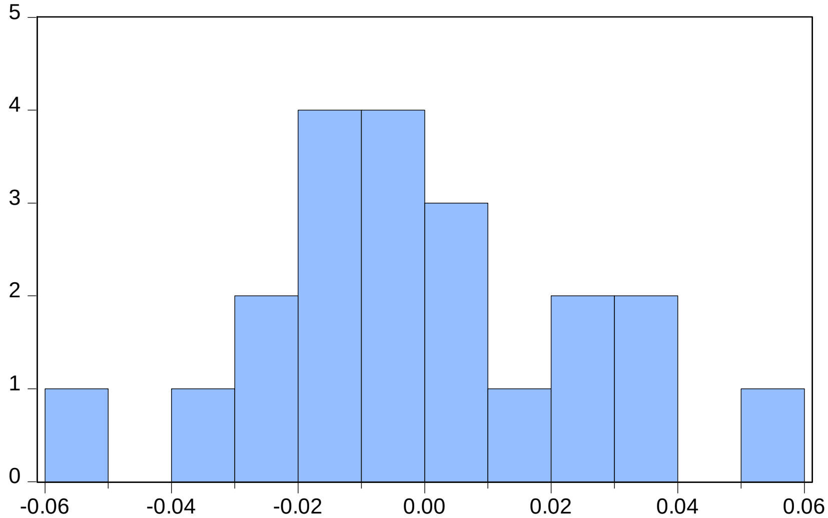
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNCO2(-1) LNMAN LNMAN(-1)
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.318152	17	0.2049
F-statistic	1.737525	(1, 17)	0.2049

GDP in services and Renewable Energy

JarqueBera Normality Test



Series: Residuals
Sample 1991 2011
Observations 21

Mean	-3.80e-16
Median	-0.005995
Maximum	0.058759
Minimum	-0.053299
Std. Dev.	0.027105
Skewness	0.291844
Kurtosis	2.697985
Jarque-Bera	0.377917
Probability	0.827821

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.602091	Prob. F(1,15)	0.4498
Obs*R-squared	0.810399	Prob. Chi-Square(1)	0.3680

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.153509	Prob. F(1,18)	0.6998
Obs*R-squared	0.169124	Prob. Chi-Square(1)	0.6809

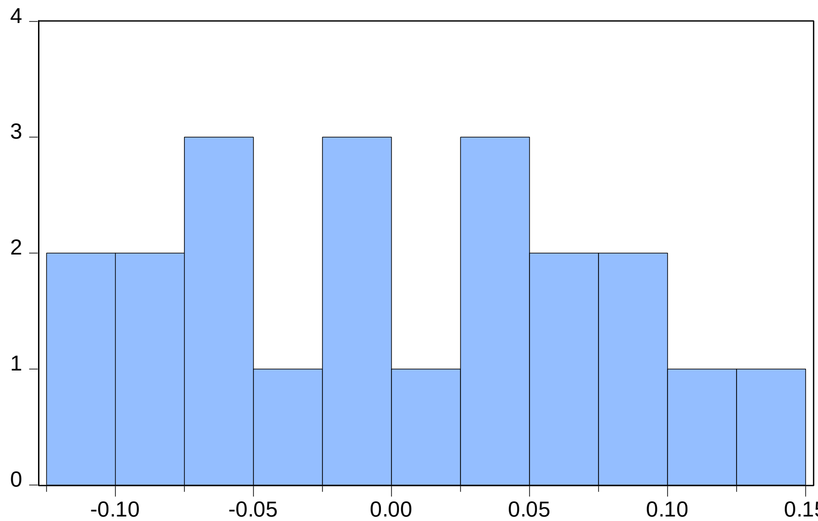
Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNSER LNSER(-1) LNRE LNRE(-1) C @TREND
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.450753	15	0.6586
F-statistic	0.203178	(1, 15)	0.6586

CO2 and GDP in services

JarqueBera Normality Test



Series: Residuals	
Sample 1991 2011	
Observations 21	
Mean	2.99e-17
Median	-0.001720
Maximum	0.138852
Minimum	-0.121019
Std. Dev.	0.076632
Skewness	0.110822
Kurtosis	1.944047
Jarque-Bera	1.018644
Probability	0.600903

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.544486	Prob. F(2,16)	0.5905
Obs*R-squared	1.338197	Prob. Chi-Square(2)	0.5122

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.166745	Prob. F(1,18)	0.6878
Obs*R-squared	0.183572	Prob. Chi-Square(1)	0.6683

Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNCO2(-1) LNSER C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.037891	17	0.9702
F-statistic	0.001436	(1, 17)	0.9702

Appendix 3: Bound test for Co-integration

Renewable Energy granger cause GDP

ARDL Bounds Test
Date: 02/23/16 Time: 14:33
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	12.16041	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.05	4.49
5%	4.68	5.15
2.5%	5.3	5.83
1%	6.1	6.73

GDP granger causeRenewable Energy

ARDL Bounds Test
Date: 03/12/16 Time: 20:23
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.295517	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

GDP granger cause CO2

ARDL Bounds Test
Date: 02/23/16 Time: 14:54
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	9.465001	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.05	4.49
5%	4.68	5.15
2.5%	5.3	5.83
1%	6.1	6.73

CO2 granger cause GDP

ARDL Bounds Test
Date: 03/12/16 Time: 14:14
Sample: 1992 2011
Included observations: 20
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	3.478648	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

Renewable Energy granger cause GDP in Agriculture

ARDL Bounds Test
Date: 02/23/16 Time: 14:11
Sample: 1994 2011
Included observations: 18
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.600285	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.05	4.49
5%	4.68	5.15
2.5%	5.3	5.83
1%	6.1	6.73

GDP in Agriculture granger cause Renewable Energy

ARDL Bounds Test
Date: 03/12/16 Time: 13:14
Sample: 1993 2011
Included observations: 19
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.569583	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

GDP in Agriculture granger cause CO2

ARDL Bounds Test
Date: 02/23/16 Time: 14:43
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	3.895340	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

CO2 granger cause GDP in Agriculture

ARDL Bounds Test
Date: 03/12/16 Time: 13:16
Sample: 1994 2011
Included observations: 18
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.186060	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

<u>Renewable Energy granger cause GDP in Manufacturing</u>

ARDL Bounds Test
Date: 02/23/16 Time: 14:18
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	2.618925	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.05	4.49
5%	4.68	5.15
2.5%	5.3	5.83
1%	6.1	6.73

<u>GDP in Manufacturing granger causeRenewable Energy</u>

ARDL Bounds Test
Date: 03/12/16 Time: 13:19
Sample: 1994 2011
Included observations: 18
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	2.465658	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

GDP in Manufacturing granger cause CO2

ARDL Bounds Test
Date: 02/28/16 Time: 13:59
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.548346	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

CO2 granger cause GDP in Manufacturing

ARDL Bounds Test
Date: 03/12/16 Time: 13:21
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	1.382568	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

Renewable Energy granger cause GDP in Services

ARDL Bounds Test
Date: 02/23/16 Time: 14:23
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.227299	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	4.05	4.49
5%	4.68	5.15
2.5%	5.3	5.83
1%	6.1	6.73

GDP in Services granger cause Renewable Energy

ARDL Bounds Test
Date: 03/12/16 Time: 13:23
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	6.462766	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

CO2 granger cause GDP in Services

ARDL Bounds Test
Date: 02/23/16 Time: 14:50
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.535743	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

GDP in Services granger cause CO2

ARDL Bounds Test
Date: 03/12/16 Time: 13:25
Sample: 1991 2011
Included observations: 21
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	0.272563	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.44	3.28
5%	3.15	4.11
2.5%	3.88	4.92
1%	4.81	6.02

Appendix 4: ARDL Short Run and Long Run Estimation

Renewable Energy granger cause GDP

ARDL Cointegrating And Long Run Form
Dependent Variable: GDP
Selected Model: ARDL(1, 1)
Date: 03/12/16 Time: 13:55
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRE)	-23.965988	12.356192	-1.939593	0.0703
C	-69.132484	10.676513	-6.475193	0.0000
CointEq(-1)	-0.9047778	0.172450	-6.406355	0.0000

Cointeq = GDP - (27.4489*LNRE + 0.9457*@TREND)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRE	27.448866	12.101794	2.268165	0.0375
@TREND	0.945684	0.502473	1.882061	0.0781

GDP granger cause Renewable Energy

ARDL Cointegrating And Long Run Form
Dependent Variable: LNRE
Selected Model: ARDL(1, 1)
Date: 03/12/16 Time: 20:22
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP)	-0.005588	0.002118	-2.638429	0.0173
CointEq(-1)	-0.045685	0.010842	-4.213734	0.0006

Cointeq = LNRE - (-0.1454*GDP + 2.2330)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	-0.145398	0.250427	-0.580601	0.5691
C	2.232997	0.730469	3.056936	0.0071

GDP granger cause CO2

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 1)
Date: 02/23/16 Time: 14:54
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP)	0.008872	0.002470	3.592125	0.0024
C	0.582210	0.095854	6.073943	0.0000
CointEq(-1)	-0.476959	0.084389	-5.651936	0.0000

Cointeq = LNCO2 - (0.0358*GDP + 0.0377*@TREND)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	0.035803	0.014741	2.428854	0.0273
@TREND	0.037684	0.005303	7.105622	0.0000

CO2 granger cause GDP

ARDL Cointegrating And Long Run Form
Dependent Variable: GDP
Selected Model: ARDL(2, 0)
Date: 03/12/16 Time: 14:13
Sample: 1990 2011
Included observations: 20

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-0.117416	0.208879	-0.562127	0.5814
D(LNCO2)	26.409109	10.352430	2.551006	0.0207
CointEq(-1)	-0.907626	0.261480	-3.471107	0.0029

Cointeq = GDP - (3.1002*LNCO2)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCO2	3.100217	0.670446	4.624112	0.0002

Renewable Energy granger cause GDP in agriculture

ARDL Cointegrating And Long Run Form
Dependent Variable: LNAGR
Selected Model: ARDL(1, 4)
Date: 02/23/16 Time: 14:11
Sample: 1990 2011
Included observations: 18

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRE)	0.748493	0.302697	2.472749	0.0329
D(LNRE(-1))	-2.032262	0.509148	-3.991495	0.0026
D(LNRE(-2))	-1.876992	0.462891	-4.054931	0.0023
D(LNRE(-3))	-1.139560	0.526356	-2.164999	0.0556
C	-4.848888	1.081918	-4.481751	0.0012
CointEq(-1)	-0.732450	0.163125	-4.490103	0.0012

Cointeq = LNAGR - (3.4913*LNRE + 0.1329*@TREND)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRE	3.491253	0.808443	4.318490	0.0015
@TREND	0.132882	0.036580	3.632598	0.0046

GDP in agriculture granger cause Renewable Energy

ARDL Cointegrating And Long Run Form
Dependent Variable: LNRE
Selected Model: ARDL(3, 0)
Date: 03/12/16 Time: 13:14
Sample: 1990 2011
Included observations: 19

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRE(-1))	0.070984	0.221436	0.320562	0.7530
D(LNRE(-2))	-0.258064	0.203037	-1.271018	0.2231
D(LNAGR)	0.080169	0.109606	0.731435	0.4758
CointEq(-1)	-0.224038	0.069853	-3.207271	0.0059

Cointeq = LNRE - (0.8113*LNAGR)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	0.811342	0.048297	16.798968	0.0000

GDP in agriculture granger cause CO2

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 0)
Date: 02/23/16 Time: 14:44
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGR)	-0.070021	0.169320	-0.413543	0.6841
CointEq(-1)	-0.216612	0.065697	-3.297160	0.0040

Cointeq = LNCO2 - (-0.4016*LNAGR + 2.8779)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.401633	0.472111	-0.850717	0.4061
C	2.877903	1.095423	2.627206	0.0171

CO2 granger cause GDP in agriculture

ARDL Cointegrating And Long Run Form
Dependent Variable: LNAGR
Selected Model: ARDL(1, 4)
Date: 03/12/16 Time: 13:16
Sample: 1990 2011
Included observations: 18

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCO2)	-0.011942	0.254437	-0.046935	0.9633
D(LNCO2(-1))	-0.071633	0.228232	-0.313860	0.7590
D(LNCO2(-2))	0.274946	0.228330	1.204161	0.2517
D(LNCO2(-3))	0.659074	0.233157	2.826740	0.0153
CointEq(-1)	-0.220059	0.065648	-3.352083	0.0058

Cointeq = LNAGR - (1.1719*LNCO2)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCO2	1.171882	0.079710	14.701751	0.0000

GDP in manufacturing granger cause CO2

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 1)
Date: 03/07/16 Time: 23:48
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNMAN)	-0.686239	0.443372	-1.547771	0.1391
CointEq(-1)	-0.203651	0.054773	-3.718102	0.0016

Cointeq = LNCO2 - (0.5852*LNMAN)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMAN	0.585216	0.036257	16.140923	0.0000

Renewable Energy granger cause GDP in services

ARDL Cointegrating And Long Run Form
Dependent Variable: LNSER
Selected Model: ARDL(1, 1)
Date: 02/23/16 Time: 14:23
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRE)	0.048591	0.111576	0.435495	0.6690
C	1.801704	0.427708	4.212467	0.0007
CointEq(-1)	-0.724041	0.172380	-4.200254	0.0007

Cointeq = LNSER - (0.5108*LNRE + 0.0245*@TREND)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRE	0.510812	0.166370	3.070346	0.0073
@TREND	0.024479	0.006862	3.567520	0.0026

GDP in services granger cause Renewable Energy

ARDL Cointegrating And Long Run Form
Dependent Variable: LNRE
Selected Model: ARDL(1, 0)
Date: 03/12/16 Time: 13:23
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNSER)	-0.028578	0.314586	-0.090843	0.9286
CointEq(-1)	-0.091526	0.025930	-3.529749	0.0022

Cointeq = LNRE - (0.4591*LNSER)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNSER	0.459071	0.057602	7.969671	0.0000

GDP in services granger cause CO2

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 0)
Date: 02/28/16 Time: 12:26
Sample: 1990 2011
Included observations: 21

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNSER)	0.293080	0.449253	0.652371	0.5224
CointEq(-1)	-0.236106	0.061724	-3.825165	0.0012

Cointeq = LNCO2 - (2.5084*LNSER -7.6471)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNSER	2.508353	1.752528	1.431277	0.1695
C	-7.647131	6.684187	-1.144063	0.2676