CARBON DIOXIDE (CO2) EMISSIONS AND GDP BY SECTORS: A STUDY OF FIVE SELECTED ASEAN COUNTRIES

BY

CHENG CHWEE LING
CHUNG ZHI LEONG
GAN PEK CHUEN
LIEW SIEW VERN
LIM ZHI HONG

A research project submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF BUSINESS ADMINISTRATION (HONS) BANKING AND FINANCE

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF BUSINESS AND FINANCE
DEPARTMENT OF FINANCE

AUGUST 2017

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.

(4) The word count of this research report is ___20556___.

Name of Student:	Student ID:	Signature:
1. CHENG CHWEE LING	13ABB06378	________________
2. CHUNG ZHI LEONG	13ABB06547	________________
3. GAN PEK CHUEN	14ABB04104	________________
4. LIEW SIEW VERN	13ABB06751	________________
5. LIM ZHI HONG	13ABB03954	________________

Date: 24 AUGUST 2017

ACKNOWLEDGEMENT

This study has been successfully completed by the assistance of various authorities. Therefore, we would like to take this opportunity to thank those who have directly or indirectly help us to complete this study. We are thankful to Universiti Tunku Abdul Rahman (UTAR) giving us the opportunity to conduct this Final Year Project 'The relationship between CO_2 emission and GDP by sectors in the five selected ASEAN countries'.

Besides, we would like to express our deepest thanks and gratitude to our beloved supervisor, Dr. Abdelhak Senadjki for his support and guidance. He always supports us by investing his full effort in guiding us to understand the things that we should know while writing our research project. His understanding in finance and economics field which guide us to overcome the problems that we faced while completing this research project. This project cannot be done and completed on time without his guidance, patience, suggestion and encouragement.

Secondly, we would like to thank our second examiner, Mr. Hoon Hui. He had helped us to improve our presentation skills and had pointed out our problems by advising regarding the understanding to this study. His advice and suggestion had helped us to improve the knowledge in this study.

Lastly, a special thanks to the group members that always stick together and work hard to come out with a good research project with effort and responsibility. Million thanks for their effort and co-operation to complete this study. Deepest thanks and appreciation to our families and friends that have been fully support to this research project, from the beginning till the end.

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 and also giving guidance in running the E-view test.

Besides, this thesis also dedicated to all group members for their co-operation, encouragement and fully support with each other during the proceeds of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATION

ADF	Augmented Dickey-Filler
AGR	Agriculture
ARCH	Auto-Regressive Conditional Heteroscedasticity
ARDL	Autoregressive Distributed Lag
ASEAN	The Association of Southeast Asian Nations
BLUE	Best Linear Unbiased Estimators
CAAPM	CA Application Performance Management
CCAPM	Consumption Capital Asset Pricing Model
CO2 / CO_2	Carbon Dioxide
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Recursive Residuals of Square
ECM	Error Correction Model
ECT	Error Correction Term
EKC	Environmental Kuznets Curve
FAO	Food and agricultural organization
GDP	Growth Domestic Product / economic growth
IND	Indonesia
JB	Jarque-Bera
Kt	Kiloton
LCU	Local Currency Unit
LM	Lagrange Multiplier
LOG	Logarithm
MAN	Manufacturing
MYS	Malaysia
OLS	Ordinary Least Square

PHL	Philippine
RESET	Regression Error Specification
SER	Services
THA	Thailand
UECM	Unrestricted Error Correction Model
VAR	Vector Autoregressive
VECM	Vector Error Correction Model
VNM	Vietnam

LIST OF APPENDICES

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. Abdelhak Senadjki. This study provides a detailed explanation of our topic we completed towards accomplishing our project goals.

The title for this report is "CO_2 emissions and GDP by sectors: A study of five selected ASEAN countries". The variables include CO_2 emissions and GDP by sectors (agriculture, manufacturing, and services). Objectives of this research are to examine the relationship between GDP by sectors and CO_2 in the long run in five selected countries, to investigate the relationship between GDP by sectors and CO_2 in the short run in five selected countries, and to understand why the effect of GDP by sectors on CO_2 is different among five selected countries from year 1983 to year 2013.

Firstly, the 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 carry out an in- depth research to see whether there is any relationship between CO_2 emissions and GDP by sectors in selected five ASEAN countries. 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 short run and long run relationship between CO_2 emissions and GDP by sectors are provided. In conclusion, this research paper concluded the overall test results, policy implications, limitations and recommendations.

ABSTRACT

This study's objective is to investigate the relationship between CO_2 emission and GDP by sectors (agriculture, manufacture and service) in the five selected ASEAN countries which are Indonesia, Malaysia, Philippines, Thailand and Vietnam. The sample size of this study is 31 years which is from 1983 to 2013. Augmented Durkey-Fuller (ADF) approach and Autoregressive Distributed Lag (ARDL) approach were applied in order to determine the short run and long run relationship of CO_2 emission and GDP of every sector. The empirical results showed that Indonesia's agriculture and services sector have long run causal relationship with CO_2 emission while manufacturing sector has no long run causal relationship with CO_2 emission. In Malaysia, agriculture sector has negative and short run causal relationship with CO_2 emission level, however, manufacturing and service sector have positive short run relationship with CO_2, and all three sectors have no long run relationship. Thailand's three sectors have both significant short run and long run relationship with the country's CO_2 emission. However, the result from Vietnam is insignificant in explaining the long run and short run relationship; there is no long run and no short run relationship for all three sectors. For Philippines, manufacturing and agriculture sector has positive bidirectional causal relationship in short run. But, there is no significant result to explain their relationship of the three sectors in long run. Lastly, this study will provide useful information for government, policy maker and public investors to regulate economic and environment more effectively. In addition, in the last part of this study, there will be some limitation about the study and recommendations will be provided for future researchers in their further research.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

According to Ab-Rahim and Xin-Di (2016), increasing of carbon dioxide (CO_2) emissions has become a huge impact of global climate warming results from the human activities. Ab-Rahim and Xin-Di (2016) reported that as greenhouse gases emissions increase will leads global temperature to increase as well, carbon dioxide emissions grabs attentions in this way. A CO_2 emission is the main source of greenhouse effect, but several studies most widely discuss in economic growth and decrease of environmental degradation by using EKC hypothesis (Managi, 2006).

Ang (2008) and Du, Wei, and Cai (2012) had found positive relationship between CO_2 emissions and economic growth (GDP). Increasing of economic growth will eventually drive the income level and CO_2 emissions to increase, there is, total CO_2 emissions and national income have a positive relationship in research of Say and Yucel (2006) over the period 1970-2002 by using regression analysis. In addition, industrialization of country takes place lead to rapidly increase in amount of CO_2 emissions. The economic growth from industrialization has increased the emissions of carbon dioxide, meaning that economic growth has a negative impact on CO_2 emissions (Ejuvbekpokpo, 2014).

According to Alshehry and Belloumi (2015); Ab-Rahim and Xin-Di (2016); and Bouznit and Pablo-Romero (2016), the economic growth affecting the carbon dioxide emissions which economic growth implies short-run unidirectional causality to carbon dioxide emissions as well as energy consumption by using the Granger-Causality test. Results in long-run relationship shows Unidirectional Granger causality happens between economic growth and CO_2 emissions and anything switching in energy consumption for GDP would give effect to the CO_2 emissions (Lean & Smyth, 2010). Another set of research also viewed economic growth do affect CO_2 emissions by using EKC hypothesis. If there were higher values per capital real GDP will causing CO_2 emissions to increase (Bouznit & Pablo-Romero, 2016). Saidi and Hammami (2015a) also stated that the effect of economic growth and CO_2 emissions will be positive however, when there is decrease in the income, there will be a decrease in CO_2 emissions as well.

Alshehry and Belloumi (2015); Arvin, Pradhan, and Norman (2015); and Deviren and Deviren (2016) found zero relationship between CO_2 emissions and economic growth; means that any changing in carbon dioxide emissions will not make any changing in economic growth. According to Arvin *et al*. (2015), tourist arrivals may increase in the level of pollution (carbon dioxide emission rate) of a country but arrivals will not increase the economic growth of a country. It is the policy makers' responsibility that should safeguard the carbon dioxide emissions rate.

According to Alshehry and Belloumi (2015); Arvin *et al*. (2015); Chaabouni, Zghidi, and Mbarek (2016); Deviren and Deviren (2016); Ejuvbekpokpo (2014); Saidi and Hammami (2015b); and Wang, Zhou, Li, and Feng (2016) stated to have causal relationship between CO_2 emissions and economic growth by running the Granger-Causality test. Alshehry and Belloumi (2015) stated that bidirectional causality occur between CO_2 emissions and economic growth. When there is an increase in real GDP per capita, so do the CO_2 emissions. In long-term, an adverse effect happens on the GDP running from CO_2 emissions.

1.1 The relationship between CO2 and GDP by sectors

1.1.1 The relationship between CO2 and GDP in Indonesia

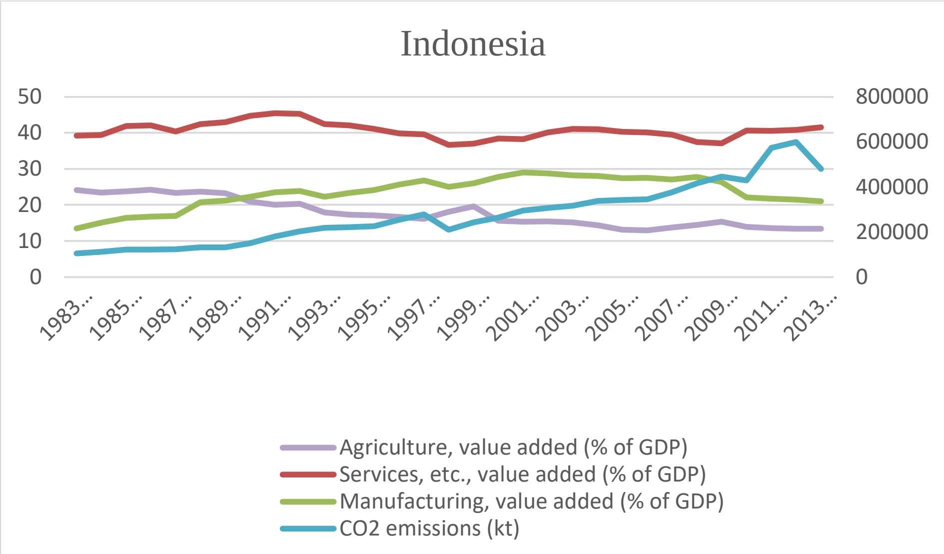


Figure 1.1 shows Gross Domestic Products (GDP) and Carbon Dioxide (CO2) emissions in Indonesia for the period 1983-2013.

Source: World Bank Data

In the report of Trends in Global CO_2 Emission, Indonesia is one of the developing countries in ASEAN that contained highest CO_2 emission level especially in the sector of international transport (service sector) compare to other countries. Due to that reason, the CO_2 emissions level in Indonesia is increasing as shown in Figure 1.1.

The Indonesia emission level increased continuously in these 31 years, 1983-2013, and a sharp drop in year 2013. The reason that may cause the increased of carbon emission from agriculture sector may cause by deforestation and expansion of land (Carlson, Curran, Ratnasari, Pittman, Soares-Filho, Asner, Trigg, Gaveau, Lawrence, & Rodrigues, 2012). Moreover, in year 1997, the CO_2 emissions level increased suddenly is due to forest fire happened during 1997 (Page, Siegert, Rieley, Boehm, Jaya, &

Limin, 2002; Duncan, Bey, Chin, Mickley, Fairlie, Martin, & Matsueda, 2003). The GDP of agriculture is decreasing slowly from year 1983 to year 1989 and decrease rapidly from the year 1990–1997. This is because Asian Financial Crisis happened in the late 1990s and the unemployment rate increase in this period. From the data given, agriculture sector contributed around 21.66% to the Indonesia's GDP in these 31 years. However, this is different with the study of Biswas (2014) which stated that agriculture sector is the main income for the household in Indonesia.

Besides, the GDP of service sector generated around 49.65% to the GDP of Indonesia and it is fluctuated in the range of 35%-45% between these 31 years. Due to the financial crisis, there is a rapid decreasing between the year 1991-1998 and hit the lowest as 36.69% in year 1998. After that, in year 1999, it starts to increase again and hit the second lowest, 37.06% in year 2009.

For the manufacturing sector, the GDP is increasing from year 1983 to year 2001 and start to decrease from year 2002 to year 2013. It also hit the highest, 29.05%, in year 2001 while the lowest, 13.43%, in year 1983.

1.1.2 The relationship between CO2 and GDP in Malaysia

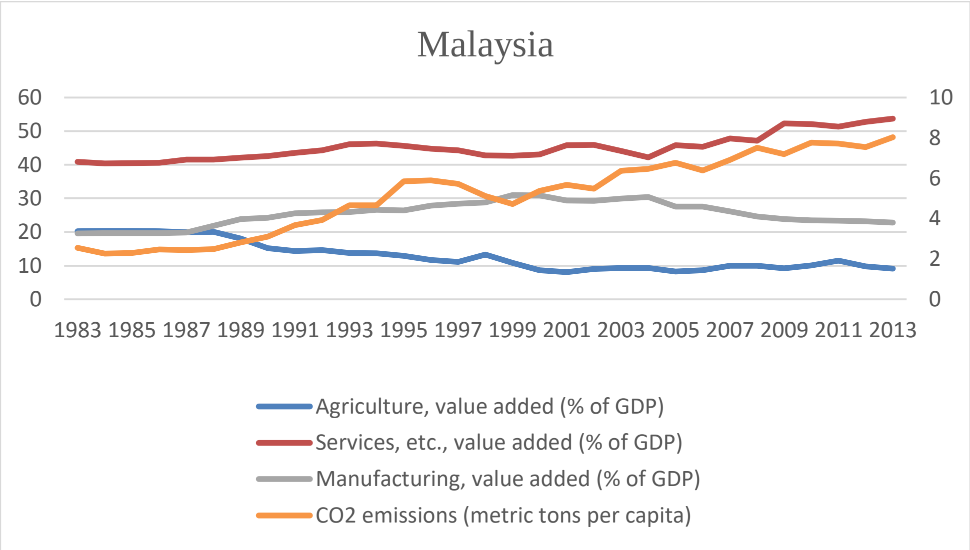


Figure 1.2 shows Gross Domestic Products (GDP) and Carbon Dioxide (CO2) emissions in Malaysia for the period 1983-2013.

Source: World Bank Data

From figure above, it is shown clearly that the CO_2 emission rises during the period 1983-2013 in Malaysia. Despite all the others reasons, services, manufacturing and agriculture are also the main reasons that causes the CO_2 level to rise in Malaysia. Throughout the years, services sector have grabbed the most attention compared to agriculture and manufacturing sectors in Malaysia. According to Afroz, Hassan, and Ibrahim (2003), land transportation is the main factor that affects the pollution of air the most, and follows by the least, industrial emissions and burning sources openly. For the period 1983-2013, 1983, 1984, 1991, 1994 and 1997 is the years that the quality of air facing the worse level in Malaysia due to haze (Afroz *et al.*, 2003).

CO_2 emissions hits the lowest of 2.26 (metric tons per capita) in year 1984 where reached the highest at 8.03 in year 2013. From figure 1.4 shows services always have the higher percentage of GDP for the period 1983-2013. Services have the lowest of 40.42 in year 1984 and then rise as fluctuate year by year, the highest of 53.70 in year 2013. Despite manufacturing and agriculture sectors, services sectors view as the most factors that affect the CO_2 emissions, but not GDP (Solarin, 2014). Over the decades, tourism development increase the CO_2 emissions in Malaysia year by year, the tourist arrivals in Malaysia keep increase according to Solarin (2014), level of CO_2 emissions increases through transportation services.

From year 1983 until year 1988, it can see that the manufacturing and agriculture have almost the same percentage of GDP but after that, manufacturing start to increase until year 2004 and after that, keep decrease until year 2013 at 22.84% of GDP. Manufacturing taking in second place owned the lowest percentage of GDP of 19.53 in year 1983 and 30.94 is the highest in year 1999. According to Hansen (2007), 11% of land area plantations in Malaysia contribute to the crude palm oil manufacturing, so it gives an impact to environment and also increase the level of CO_2 emissions.

On the other hand, agriculture starts to decrease from year 1988 until year 2000, considered unstable after year onward. Agriculture seems to be the least factor among the three that give impact to cause the level of CO_2 emissions increases. Agriculture have the highest percentage of GDP of 20.35 in year 1984 within the period 1983-2013 but after, it shows decreasing and have the lowest in year 2001 of 8.01.

1.1.3 The relationship between CO2 and GDP in Philippines

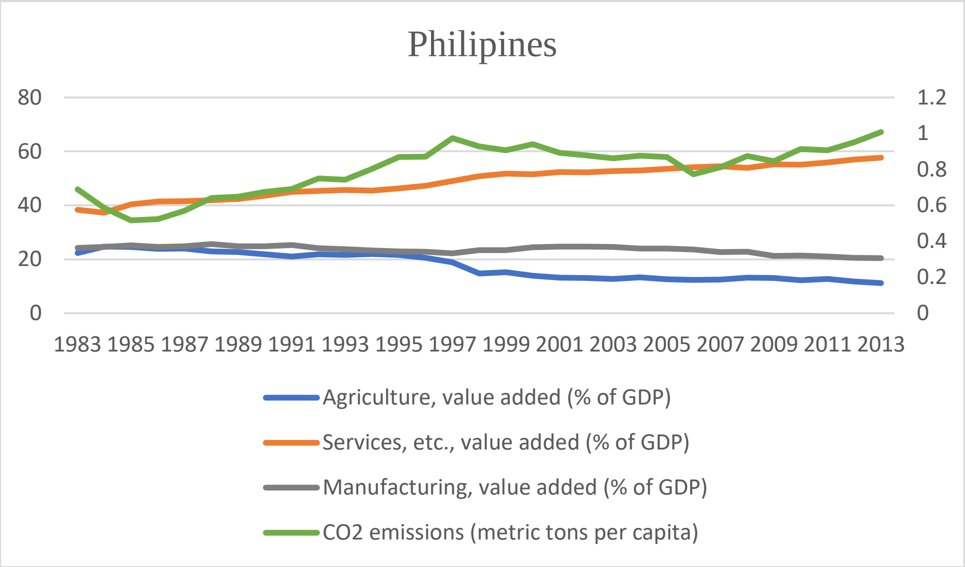


Figure 1.3 shows Gross Domestic Products (GDP) and Carbon Dioxide (CO2) emissions in Philippines for the period 1983-2013.

Source: World Bank Data

From the figure above, compared to Thailand, Malaysia, Vietnam and Indonesia, Philippine are having the lowest CO_2 emission among these countries throughout. The highest CO_2 emission for Philippines is in the year of 2013 with 1.0068 metric tons per capita. The lowest CO_2 emission is on year 1985 of 0.5163 metric tons per capita. According to Ramesh and

Howlett (2006), there is a gradually decrease from 1983 to 1987 is that in year 1985 there is a more significant rise in fossil fuels electricity production. The Philippines' carbon emissions growth has increased in a total of 0.2665 metric tons per capita since 1990 to 2000. According to Palacan-Tan, Dy, and Tan (2016), Philippines is one of the lesser urbanized countries and has an employment structure which is found more in high-income-level economies. In year 2009, more than 52% of the workers been hired in the services sector, 22% was in the manufacturing sector, and the lowest is in the agriculture sector which consists of only 13%. From year 1985 onwards, there have been a drastic increase till the year on 1997 but has experience in drop to 2006 but it had also increase gradually annually till 2013.

Agriculture remains significant in decreasing as the Philippines' economy has been slowly taken over by service and manufacturing sectors due to the advanced in industrialization, employing about 12 million people or 30% of the total labour force. In 2012, the agricultural sector still holds on for 11% of the county's Gross Domestic Product. Since 2000, the service sector of transportation which includes taxis, buses and car in yearly has contribute in the gradually increased of vehicles and has averaged in 12%. 2012, there were 7,463,393 motor vehicles (Lim, Lim, & Yoo, 2014).

Service is the highest and is the dominant sector among the 3 sectors including manufacturing and agriculture, as the road sector has been the main focus than other sectors in Philippines and had occupied for nearly 88% in the country, as service sectors is taking over, there is an obvious downwards slopping trend with slight decrease for both the manufacturing and the agriculture sectors. According to Gota (2014), the increase of income will lead to high growth in owning a vehicle and using it to set up businesses and hence increase the demand of transportations.

Palacan-Tan *et al*. (2016) states that urbanization has a huge effect on carbon dioxide emission as the lower-middle income countries which are less urbanized tend to produce lesser carbon dioxide emissions as it has lesser structural changes and that compared in the 1990's CO_2 emission is mush lesser than in the 2000's. As in the 1990s, the government of Philippines has brought in economic reforms to business growth and had helped Philippines to have higher growth and a minimal impact from the Asian financial crisis in 1997 (Mukhopadhyay & Thomassin, 2010).

1.1.4 The relationship between CO2 and GDP in Thailand

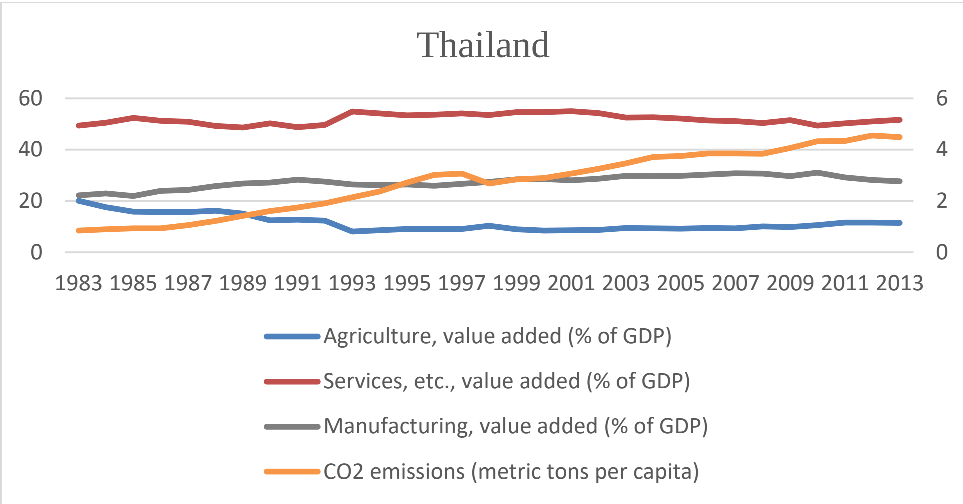


Figure 1.4 shows Gross Domestic Products (GDP) and Carbon Dioxide (CO2) emissions in Thailand for the period 1983-2013.

Source: World Bank Data

From the figure above, the percentage of GDP for agriculture, services and manufacturing sectors are having an inconsistent changes during the year 1983 to the year 2013 in Thailand, while the amount of CO_2 emissions also having an unstable changes during the year 1983 to the year 2013 in Thailand. The percentage of GDP for services sector hits the lowest percentage in year 1989 with 48.67% where it reached the highest in year 2001 with 54.95%. In addition, the percentage of GDP for manufacturing sector is having an inconsistent change from the year 1983 until the year 2013. It reached the lowest percentage in year 1985 with 21.92% where its highest percentage is 31.09% in year 2010. The percentage of GDP for agriculture sector, it hits the lowest percentage in year 1993 with 8.03%.

During the last 10 years, the percentage for this sector had an inconsistent change of small changes. In these 10 years, it has reached the lowest percentage of 9.20% in year 2005 while it reached the highest percentage of 11.60% in year 2011.

Furthermore, the amount of CO_2 emissions increases sharply from the year 1983 until the year 1997 with the lowest amount of 0.8460 (metric tons per capita) until the highest amount which is 3.0707 (metric tons per capita). After the peak amount in year 1997, on year 2001 it has slightly decreased to 3.0687 (metric tons per capita). During year 2002 to the year 2013, the amount of CO_2 emissions is having an unstable changes where their lowest amount is 3.2481 (metric tons per capita) in year 2002 and the highest amount is 4.5444 (metric tons per capita) in year 2012. Overall, the amount of CO_2 emissions in Thailand is increasing as well due to the number of transportation in Thailand increased sharply over the year. When the number of transportation increases, the CO_2 emissions will increase as well, transportation is one of the main reasons that cause the CO_2 emissions to increase sharply.

Besides that, Thailand has become one of the top tourism places for traveling. When the number of tourist increases, it will also lead to the increase of CO_2 emissions. According to Lee and Brahmasrene (2013), they obtained the data from the European Union (EU), investigate the influence of tourism on economic growth and CO_2 emissions. From their study's result showed that tourism brings a negative and significant impact on high emissions of CO_2. Deforestation in Thailand is among the main factors that causes higher CO_2 emissions (Lee & Brahmasrene, 2013). A lot of trees has been taken down and therefore causing the forest in Thailand to slowly disappear. Therefore, World's Bank Forest Carbon Partnership Facility has given a grant of US$3.6 million to lend a helping hand to Thailand to get this matter solved and also to come up with a strategic plan to further lessen the harmful emissions that has been emitted due to the uncontrollable deforestation and forest degradation (Kongrukgreatiyos & Chung, 2016). Moreover, according to Kongrukgreatiyos and Chung (2016), that Thailand has been an active participant in the global climate change dialogue, and has been making great effort to be the top in reducing the level of carbon dioxide.

1.1.5 The relationship between CO2 and GDP in Vietnam

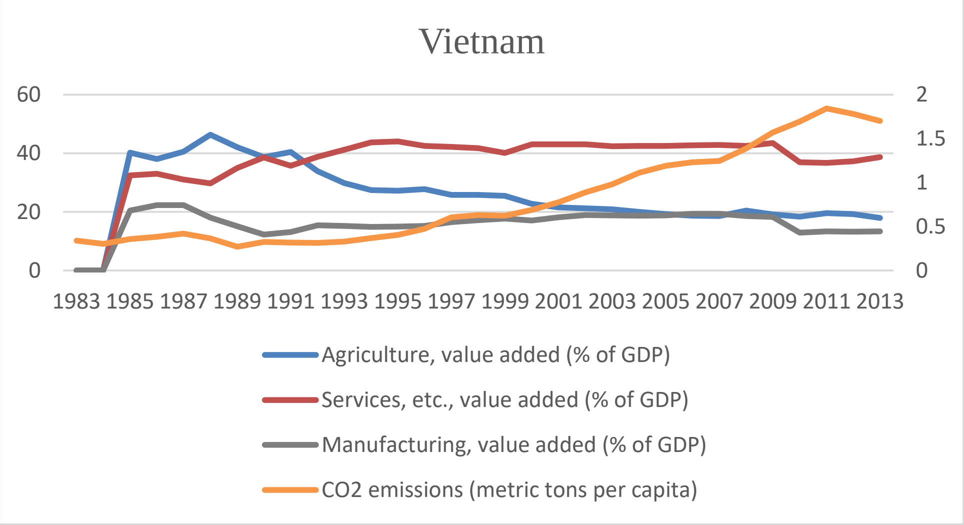


Figure 1.5 shows Gross Domestic Products (GDP) and Carbon Dioxide (CO2) emissions in Vietnam for the period 1983-2013.

Source: World Bank Data

From the figure 1.5, CO_2 emissions have an upward trend curve showing it has increased unstably for the period between 1983 till 2013. After year 2000, the total carbon dioxide emissions start to increase the substantial amount, and shows how the environment in Vietnam declines as years passes by. Vietnam has the lowest level of CO_2 emissions of 0.30 (metric tons per capita) in year 1984 and hit the highest in year 2011 at 1.84. According to Chaudhry and Ruysschaert (2007), the level of CO_2 emissions tends to be higher in year 2000 due to introduction of land sector. Land sector is told to be one of the main sources of emissions that have been accounted for 53% of the total domestic greenhouse gases in year 2000 (Chaudhry & Ruysschaert, 2007). With these opportunity, a lot of efforts put in to increase forest's cover in the last few decades, and has successfully expanded its land area to an estimation of 39.7% in year 2011 (Avitabile, Schultz, Herold, De Bruin, Pratihast, Manh, Quang, & Herold, 2016).

Agriculture sector had been promoting well from year 1985 to 1991, as it seems to have a higher percentage of GDP within mentioned years and has reached its highest in year 1988. After year 1991, Vietnam had started to focus on the other sectors except agriculture sector; as it still seem to be the lowest in year 2013 with 17.96%. In the mid-year 2000 from year 1990 till 2013, Vietnam tries to enter into manufacturing coffee, but due to unknowledgeable of the field and excessive application of fertilizer and water when produced, the farmers has not given proper training, the agriculture sector did not drive up Vietnam but ended up in promoting a lower percentage of GDP.

On the other hand, figure 1.5 shows clearly that Vietnam had put a lot of effort in promoting services sector as it drive well than manufacturing and agriculture sectors. Despite that there is no data in the first 2 years, 1983-1984; it has the lowest GDP of 29.74% in year 1988. The percentage of GDP for services sector steadily increases from year 1985 to 1992 from 32.48% to 38.80%. It shoots up skyrocketed till the year 2009, and gradually decreases from 2010 to 2013. The reason services sector contributes the most economic growth can be tied to tourism in Vietnam. A political and economic change in Vietnam will be the factors that caused number of tourists from other countries rising and to visit Vietnam. The tourists that visit Vietnam has since then increased from 92,500 in year 1988 to 3,583,486 in year 2006 (Phan, 2007).

Moreover, Vietnam focuses the least in manufacturing sector compared to services and agriculture sectors. Manufacturing have the same percentage of GDP of 22.37 in year 1986 and 1987, the highest. It reached the lowest in year 2010 with 12.95% of GDP. For period 1983-2013, manufacturing sector has not many changes as the trend is move along in line. From year 1985 to 1987, the percentage of GDP is high as the growth in the industrial sectors is distributed unevenly and has helped production levels to be restored.

1.2 Problem Statement

Carbon dioxide (CO_2) emission has been addressed as an acknowledged problem and has a significant impact on economic growth. CO_2 emission is formed by combustion of carbon known as a non-poisonous gas which lacking the qualities and effects as a poison (Ejuvbekpokpo, 2014). Scientific showed that CO_2 emissions will give a negative impact to the atmosphere which is in the form of harmful greenhouse gases that will contribute towards the global climate warming. On the other hand, GDP represents as the monetary value of all goods and services produced within a nation's geographic area over certain duration of time. Ejuvbekpokpo (2014) says that the economic growth from industrialization has increased the emission of carbon dioxide and anything switching in energy consumption for economic growth will affect CO_2. Besides, according to Bouznit and Pablo-Romero (2016) shows that the results if there were higher value per capital real GDP, it will cause the CO_2 to increase. According to Hao, Chen, Wei, and Li (2016), changes in population in certain area will affect the energy consumption which can cause changes in CO_2 emissions.

The selected 5 ASEAN countries which are Indonesia, Malaysia, Philippines, Thailand, and Vietnam have the highest level of CO_2 emissions out of other countries (World Bank, 2009). Therefore to effectively reduce CO_2 emissions subjected to challenging task and needs a much focused effort as the level of affluence is particular strong by far the largest contributor to emissions growth in the ASEAN such as in Indonesia, Malaysia, Philippines, Thailand and Vietnam. The average annual CO_2 emissions due to increased standard of living in the ASEAN had been growing at an increasing rate. These trends reflect the patterns of economic growth in most countries in the region; this might be a reflection of economic development stage as countries move from a low-income towards high-income level, the potential of increasing affluence to contribute to future growth in emissions is significant (Sandhu, Sharman, & Vaiyavuth, n.d.). CO_2 emissions having upward trends mainly caused by the contribution of the 3 sectors known as agriculture, manufacturing, and services which all play an important role to drive CO_2 emissions to higher level. According to Alam (2015), CO2 emissions from agriculture, manufacturing, and services sector have contributed to the greenhouse effect.

Transportation addressed as a main source in the services sector as well as for the manufacturing sector which contribute high CO_2 emissions due to the increase of tourist in a country as well as import and export for the manufacturing goods. For agriculture sector, plantation is being treated as a main source as it use large amount of mechanism in order to manage the agriculture. Besides, high CO_2 emissions factories that produce and manufacture goods too jointly contribute CO_2 emissions into manufacturing sector. In order to minimize and to be able to prove that these problem are the causes of the increasing in CO_2 emissions in these sectors, further investigation need to be carried out.

1.3 Research Question

- How does GDP by sectors causes CO_2 emission in the long run in 5 selected countries.
- How does GDP by sectors causes CO_2 emission in the short run in 5 selected countries.
- Why the effect of GDP by sectors on CO_2 emission is different among 5 selected countries.

1.4 Research Objectives

- To examine the relationship between GDP by sectors and CO_2 emission in the long run in 5 selected countries.
- To investigate the relationship between GDP by sectors and CO_2 emission in the short run in 5 selected countries.
- To understand why the effect of GDP by sectors on CO_2 emission is different among 5 selected countries.

1.5 Significant of study

This research studies the relationship of gross domestic product (GDP) by sectors (agriculture, manufactures, and services) and carbon dioxide (CO_2) emissions in 5 selected countries (Philippine, Indonesia, Thailand, Vietnam, and Malaysia) in long-run as well as short-run, and understands the impact among the selected three sectors. Every sector provides different impact on GDP as well as on the CO_2 emissions. By narrowing down the scopes to three sectors, as it will be easy for the policy-makers and the government of each country to figure out the problem and provide guidelines and plans which will help the country to maintain and improve the level of CO_2 emissions, which will have an impact to the GDP in the countries. This study will also help to analyze which sector among the three will bring the most effect on the emissions of carbon dioxide as well as GDP.

The result of the study should help the policy maker on the specific area of sectors of the countries to be focus to eliminate high level of CO_2 emissions in the sectors that contribute to decrease GDP, which overall raises the level of CO_2 emissions and GDP. Besides, government should introduce and implement policy in lowering down the level of CO_2 emissions in order to reduce the amount of heat-trapping gases releases to the atmosphere that being harmful to environment.

1.6 Conclusion

This study is to examine and identify the relationship of carbon dioxide (CO_2) emissions with gross domestic product (GDP) by sectors (agriculture, manufacture and services) in selected five ASEAN countries (Indonesia, Malaysia, Philippines, Thailand, and Vietnam), in both long-run and short-run. This study will provide important information and policy which will act as a reference and a guideline to the countries in how to manage their GDP and CO_2 emissions level.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The aim of this study is to carry out various methods of hypothesis to see if there is any Granger-causality relationship that existed between both variables, CO_2 emissions and GDP by sectors in agriculture, manufacturing, and services, and also carry out an in-depth research to see whether there is any relationship between CO_2 emissions and GDP by sectors in selected 5 ASEAN countries (Indonesia, Malaysia, Philippines, Thailand, and Vietnam) that are being tested.

2.1 Theories / Concepts of CO2 Emission and Economic Growth

2.1.1 Growth Hypothesis

Growth hypothesis is a unidirectional causality that runs in the form of energy to economic growth, and a slight positive change in energy may have a positive effect on the growth process (Magazzino, 2014). According to Magazzino (2016), it had been suggested that the energy is an important component in growth, to capital and labour as an input production factors either directly or indirectly. Therefore, energy consumption increase will cause an increase in GDP and is known as "energy dependent", which means that the energy conservation policies may be implemented which is to reduce the environmental pollution on the opposite effects on real GDP (Behera 2015). More energy and GDP used will tend to increase the carbon dioxide emission (Mohsen & ali Rezaei, 2013).

If Granger-causes are used for the growth of the economy, then energy conservation policies which are aimed at protecting and preserving the environment will be expected to worsen the process in the growth of the economic. As stated by Farhani, Shahbaz, and Ozturk (2014), that it should be discouraged to apply the policies blindly, and to be encouraged to explore various sources of lower consumption and polluting energy to help the rises of economic growth. Results show economic growth and CO_2 emissions are free from Granger causality (Farhani *et al*., 2014). But Kulionis (2013) had discovered that energy Granger is the cause for GDP by using multivariate VAR model of GDP by using 21 extended data to test in USA. The result turn out by showing energy consumption and GDP for the period of 1947 till 1979 in USA is free from causality for each other. It was being studied in several different countries and the results are different for every country.

As stated by Saatci and Dumrul (2013), there is zero causality relationship between GDP and energy consumption for Poland, UK and USA, but there is unidirectional causality for South Korea of GDP to energy consumption, as for Philippines from energy consumption to GDP. Limitations on the energy usage may reversely make an impact on economic growth while the increases in energy bring an effect to the economic growth. Being said that energy is one of the limited factors to economic growth and to the supply of energy which will cause a negative impact on economic growth.

2.1.2 Conservation Hypothesis

Economic growth tends to affect CO_2 emissions in both long-run and short-run with proof that support the existence of unidirectional Granger-causality from economic growth to energy use (Alshehry & Belloumi, 2005; Ab-Rahim & Xin-Di, 2016; and Bouznit & Pablo-Romero, 2016).

According to Tiwari (2011), running of Granger-causality test highlights the Conservation Hypothesis by showing negative relationship exists between GDP and CO_2. Introduction of technologies that produce low carbon able to drive the GDP output to grow further and lower down the level of CO_2 emissions (Tiwari, 2011). In long-term, the relationship between economic growth and CO_2 emissions is unidirectional Granger causality, anything switching in energy consumption for economic growth will give an impact to the CO_2 emissions (Lean & Smith, 2010). According to Lean and Smith (2010), consuming too much energy in long-term will bring effect to economic growth and cause the changes in the level of CO_2 emissions, whereas in short-term, it may help in a way of promoting the economic growth to grow rapidly without much effect to CO_2 emissions. By using EKC Hypothesis, it showing the same results as Conservation Hypothesis do, which showed economic growth will affect CO_2 emissions (Bekhet & Yasmin, 2013).

According to Tiwari (2011), implication of energy conservation policies intended to reduce consumption of energy and level of CO_2 emissions, but not GDP. Besides, implementation of national green technology policy able to decrease the level of CO_2 emissions and at the same time ensures the GDP is increasing sustainably (Mugableh, 2013). Energy policy introduced to limit the people on use less the energy and the purpose is to reduce the level of CO_2 emissions. According to Tiwari (2011), introduction of energy policy to be considered as conservative because economic growth will not affected by how much the energy been use, but energy consumption able to affect or give impact to grow the level of CO_2 emissions. Actions taken by government to set a limit to the use of energy might able to ensure the stability of economic growth and make the environment stay clean, reduce the level of CO_2 emissions comes hand by hand with the action taken (Tiwari, 2011).

There is positive impact between GDP and CO_2 emissions, in long-run. According to Begum, Sohag, Abdullah, and Jaafar (2015), low carbon technologies able to promote long term economic growth well while reduce the CO_2 emissions if transform significantly as renewable energy and energy efficiency. Saidi and Hammami (2015a) also stated that economic growth and CO_2 emissions affect each other positively however, when there is decrease in the income, there will be a decrease in CO_2 emissions as well. Development of decision making tools in overcomes the issues of CO_2 emissions and lower down the use of energy is necessary to achieve sustainable economy to promote economy growth (Fong, Matsumoto, Ho, & Lun, 2008). According to Tiwari (2011), government focus too much in importing goods from other countries will resulting imbalances in macroeconomic as import is greater than export. Import too much will drive level of CO_2 emissions increase as it contributes energy use. Amount of import and export has to be adjusted by government to make the macro economy balance and reducing the level of CO_2 emissions.

2.1.3 Feedback Hypothesis

Feedback hypothesis means that a bi-directional causality exists between CO_2 emissions and economic output (GDP). In other words, it is to see whether both variables would affect each other in the event if something happened to a country. It has been found out that the bidirectional relationship between CO_2 emissions and GDP means that environment degradation will have a causal impact on economic growth, and thus it may reduce the output in the long run. The feedback hypothesis, in which the bidirectional causality exists, has stated that energy consumption and GDP will simultaneously affect each other and can be served as complements to each other. The increase of energy consumption will lead to increase of CO_2 emissions, and GDP will increase as well (Kalimeris, Richardson, & Bithas, 2014). Feedback hypothesis's policy implications also has a similarity with growth hypothesis, measures of energy conservation will eventually reduce the economic growth (Menegaki, 2014). According to Belke, Dreger, and de Haan (2010), by shifting less efficient sources of energy to ways more efficient and options that are less polluting, which in turn reduce CO_2 emissions that may stimulates economic growth. Moreover, Ben Jebli, Ben Youssef, and Apergis (2014) has also found out that electricity consumption and economic growth have an existence of bidirectional causal relationship in between in high and upper middle income countries, for long run and short run. According to Omri (2015), to reduce CO_2 emissions, countries that have serious issues in environmental problems need to accept policies of energy conservation. Researching and investing in clean energy should also be part of an important process to control the CO_2 emissions (Omri, 2015). Feedback hypothesis also implies energy consumption and GDP would affect CO_2 emissions since interdependent relationship do exists, every single component turn to be complement to each other (Kulionis, 2013). Thus, feedback hypothesis is being said supported by GDP and energy consumption that the bidirectional Granger causality do exists between them. According to Yang (2000) found out that the total amount of energy consumption and GDP have bidirectional causality in between.

2.1.4 Neutrality Hypothesis

Neutrality hypothesis means the two variables which are CO_2 emissions and GDP has no causal relationship. In other word, it also means that there is no any impact that will affect each of the variables.

According to Sari and Soytas (2009), their study suggested that none of the countries have to sacrifice economic growth in order to reduce CO_2 emissions. This evidence showed that CO_2 emissions will not be affected by GDP or GDP will not be affected by CO_2 emissions. In addition, according to Dodman (2009), he found out that there is not an inevitable relationship between increasing of prosperity in that country and increasing of CO_2 emissions. Therefore, it means that when a country is keep increasing prosperity, it will lead to increase in GDP of the country. Thus, from Dodman (2009)'s study showed that CO_2 emissions and GDP have no causal relationship between each other.

Granger causality test implemented to indicate that there is zero statistically significant relationship exists between CO_2 emissions and GDP (Kulionis, 2013). Furthermore, according to Ben Jebli *et al*. (2014), CO_2 emissions and GDP are free from short-run causality, represent that increases in CO_2 emissions will not affect the economic activities development, while increases in economic growth are not expected to have any impact on the environmental quality such as CO_2 emissions. According to Hamrita and Mekdam (2016), the study provided evidence to support neutrality hypothesis which has insufficient evidence of causality running between CO_2 emissions, GDP and energy consumption by using Granger causality approach.

Energy consumption and CO_2 emissions has a positive relationship. For instance, Lean and Smith (2009) examined that there is significant positively association between energy consumption and CO_2 emissions. Similarly, according to Niu, Ding, Niu, Li, and Luo (2011), their study showed energy consumption and CO_2 emissions has positive relationship in eight Asian economies. However, the study's result from Cheng (1999) showed economic growth will not drive any effect to energy consumption both in short-run and long-run by using Granger causality method.

2.1.5 Environmental Kuznets Curve (EKC) hypothesis

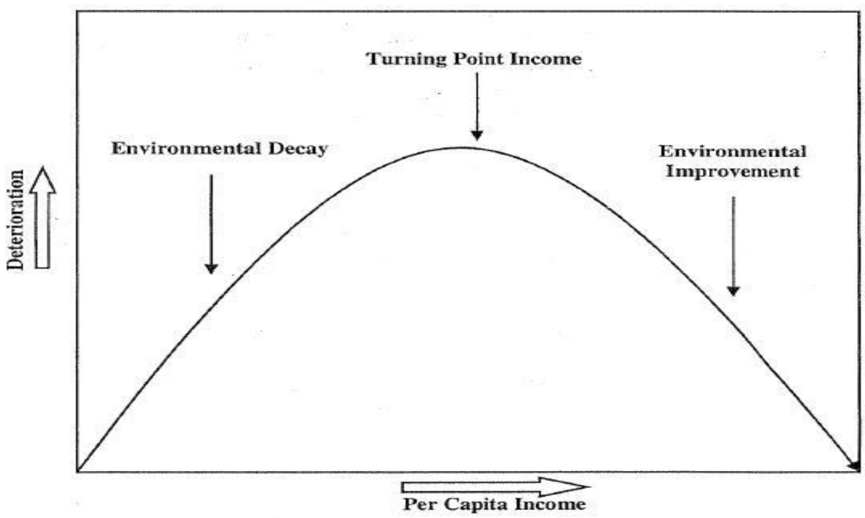


Figure 2.1 Environmental Kuznets Curve hypothesis

The other term for Environmental Kuznet Curve (EKC) known as "Stage of economic growth" and it postulates downward curve relationship between CO_2 emissions and GDP of a country (Dinda, 2004). EKC discussed in 3 phrases. At the first stage, society will focus on primary resources, for example in agriculture sector, for their necessary consumption. So, an increase in emission (per capita) will lead GDP (annual growth) increase in certain level. After necessary consumption is fulfilled, society will switch to secondary sector, example for manufacturing, which increase emission the most, and this is stage 2. There is a turning point which means when the GDP percentage increases up to a certain threshold level and beyond a threshold level pollution decreases and environmental quality improved (Alam, 2015). In this stage, CO_2 emissions will not increase anymore while income per capita is increasing. When needs are fulfilled, society moves from secondary to tertiary sector (services as example) in stage 3 which contained least pollution compare among these 3 sectors. In this stage, increasing in CO_2 emissions might not force GDP increase but there will have a decreasing in income per capita.

Normally, EKC used as a technically specified measurement for environmental quality changed (Bak, Chong, Ho, Phoon, & Teng, 2016). This is due to Heidari, Katircioglu, and Saeidpour (2015) found that EKC hypothesis is consistent and more flexible to describe in the countries they studied. However, not all researchers can prove EKC hypothesis in their studies. For example, Saboori and Soleymani (2011) found that EKC hypothesis is inconsistent in explaining their research result due to EKC is more suitable to explain long run relationship. Other than that, Hill and Magnani (2002); Dinda (2004); and Stern (2004) showed that most of the EKC studies are using panel or cross section data of countries to establish a relationship between GDP growth and CO_2 emission level.

On the other hand, inverted-U shape is not found in EKC hypothesis. Mazzanti, Montini, and Zoboli (2007) found that, a different shape of EKC is found in different sectors. In their research, most of the results from service sector tend to present an inverted-N shape. For manufacturing sector, there is a mix of inverted-U and inverted-N shape and it is depending on the emission that is considered.

2.2 Previous Empirical Studies

2.2.1 Relationship between CO2 and GDP by sectors in Indonesia

From the study of Osu, Okonkwo, and Ujumadu (2016) found that, initially, economies of developing country often relied on the heavy infrastructure project which sector that produce the most CO_2 emissions into atmosphere. According to Alberola, Chevallier, and Cheza (2008), manufacturing sector is significant in identifying the CO_2 emissions level of a country and showed that manufacturing sector is having the highest emission level among the 3 sectors.

From Figure 1.1 we knew that CO_2 emissions and GDP in manufacturing in Indonesia had a causal relationship which means they are affecting each other. By studying the data, CO_2 emissions and GDP in manufacturing increase simultaneously during the period 1983-2013 and its turning point is in the year 1997. However, from year 1997 until 2013, the GDP in manufacturing starting to shrink but the CO_2 emission per capita do not decline in same proportion as the total by which the economic growth increase and this is same as what York (2012) studied. York (2012) found that the CO_2 emission is not only relying on the size of the economy but also growth pattern that will lead to the size.

There is bi-directional relationship between CO_2 emissions and GDP in agricultural, it showed that they will cause each other to increase and decrease (Zaman, Khan, Ahmad, & Rustam, 2012). Most of the emissions that were found in agricultural sector came from the agriculture technology factors such as fertilizers, tractors, cereal productions, agriculture irrigated land and etc. Other than that, Evrendilek and Ertekin (2002) found out that agricultural production is not suitable for all countries, for example, Turkey. This is because it will lead to an inequitable economic growth (poverty and overconsumption), rapid population growth and degradation and loss of croplands. Besides, agriculture sector that increase the emission growth will also disturb the life-supporting biogeochemical cycles.

Referring back to the Figure 1.1, when economic growth in agriculture increased, CO_2 emissions will decrease and vice versa. For example, if the consumption demands on agriculture increase, they will increase the production of agriculture and the level of pollution will also increase because more technology is used (Zaman *et al*., 2012). On the other hand, production in agriculture increase will lead to the higher GDP. This is because they can export their product to foreign country and improve the country's economic growth (Reilly & Hohmann, 1993).

As it has been known that service sector produce least emission gas among these 3 sectors and the service that produce highest emission gas which is transportation. This is due to the increasing in export and import goods and services (Davis & Calderia, 2010). Davis and Calderia (2010) said that the reason of movement of CO_2 emissions in service is due to the consumption-based while Krackeler, Schipper, and Sezgen (1998) found it is based on the population. Other than that, fuel for electricity that used in commercial building also will affect the level of emission (Krackeler *et al*., 1998).

Also from Figure 1.1, CO_2 emissions and service line are increasing together and do not shows there have causal relationship between this 2 factors. Results showing not all of the service will affect the CO_2 emissions level by improving the country's GDP.

2.2.2 Relationship between CO2 and GDP by sectors in Malaysia

According to Mendelsohn, Nordhaus, and Shaw (1994), Ricardian method is the suitable approach to determine relationship between CO_2 emissions and agriculture with the use of cross-sectional as it measures the farms values in different climates. Experimental method on the other hand is used to examine the effects produced by CO_2 emissions directly (Mendelsohn, Dinar, & Williams, 2006). According to Mendelsohn *et al*. (2006), GDP in agriculture and CO_2 emissions has a positive relationship as rises in precipitation is actually brings benefits to economic growth and able to lower down the level of CO_2 emissions in Malaysia. Unfortunately, increase in sea level will bring negative impact which leads to increase in coastal damages (Mendelsohn *et al*., 2006). According to Mendelsohn *et al*. (2006), developed countries less sensitive to changes in temperature for agriculture sector compared to developing countries as it have latest technology that able to react substitutable to climate, that is, increase of energy use for technology leads to rises in level of CO_2 emissions however, agriculture considered a small portion of GDP in rich countries. Subsidy in petroleum prices in Malaysia leads to rise in economic growth but it need more energy to support and resulting level of CO_2 emissions increase (Begum *et al*., 2015).

Moreover, Vector Error Correction Model (VECM) and Autoregressive and Distributed Lag (ARDL) Model was implied, as a studies for relationship between GDP in agriculture and CO_2 emissions. According to Asumadu-Sarkodie and Owusu (2016), percentage change in agriculture sector drive primarily by CO_2 emissions. Increase of CO_2 emissions will give negative effect to agriculture sector such as in production of fruit, production of vegetables, production of cocoa bean, and so on in Malaysia (Asumadu-Sarkodie & Owusu, 2016). Developing countries are more likely to ignore the issues produced by CO_2 emissions. According to Asumadu-Sarkodie and Owusu (2016), short-run causality from agriculture to CO_2 emissions was found out by using VECM test, but absence of causality relationship in long-run by using ADRL.

According to Begum *et al*. (2015), economic dominant of Malaysia has shifted to industrial sector from year 1970 to 1980, the consumption of energy increase at the same time as years passed by. Industrialisation generates more income to economy growth but also creates more problems to environment which causes the level of CO_2 emissions to rise (Begum *et al*., 2015).

Furthermore, urban planning has a very close relationship with CO_2 emissions and GDP in manufacturing sector (Fong *et al*., 2008). Spatial planning to industrialise a country play an important role either promote economic growth in right trend or produce CO_2 emissions which is harmful to environment. Energy use involve to give impact to economic growth as process of urban planning to achieve economy goal need to consume a lot of energy, thus issues of CO_2 emissions occurred. According to Fong *et al*. (2008), excessive use of fossil fuel and land use change in Malaysia is the factors that cause the level of CO_2 emissions increases year by year. Besides, big cities are also the factor that creates more CO_2 emissions as nowadays, people are looking for high living standards and plentiful materials (Fong, Matsumoto, Lun, & Kimura, 2007, September; October). These also one of the reasons rose of energy consumption and create CO_2 emissions issues. Based on Fong *et al*. (2008), level of CO_2 emissions in Malaysia increasing rapidly due to country become more industrializes. Furthermore, introduction of new technology to have better life such as air-conditioners give significant impact on energy consumption.

According to Fong *et al*. (2008), transportation considered large fraction of GDP in services and is the factor that giving rise to CO_2 emissions. As generation become more and more industrializes, perception of social status that drive people to have own vehicles, that is, fuel vehicles needed to running the transportation resulting release of CO_2 emissions. The level of CO_2 emissions increase because of the demand for transportation rise, and contribute a lot of energy (Fong *et al*., 2008). According to Begum *et al*. (2015), economy in Malaysia currently shifts towards services sector which focus more on energy management system. The energy sources use mainly based on fossil fuels (Indati & Bekhet, 2014). As Malaysia currently in developing progress, more energy needed and will cause level of CO_2 emissions increase. Introduction of public transportation is one of the action taking by Malaysian government to reduce release of CO_2 emissions.

2.2.3 Relationship between CO2 and GDP by sectors in Philippines

Urbanization has positively less-than-unity elasticity of CO_2 emissions. Negative elasticity usually can be found in advanced countries where there is a changed of structural, high technology and improvements in carbon dioxide emissions reductions. Energy consumption from service sector such as transportation has a higher carbon dioxide emission (Palanca-Tan *et al*., 2016).

Lean and Smith (2009) had proposed that the Unidirectional Granger causality runs as electricity consumption to economic growth for long term. An increase in electricity consumption will results a much high amount of GDP as it is due to an addition of the direct effect of energy used that generate high rates of economic growth, high electricity consumption and as a result an upward growing of CO_2 emissions, that will indirectly affect the rate of employment and energy services.

Palanca-Tan *et al*. (2016) had mentioned that even though the Philippines is a fast growing economy country with a low income economy, but it have an employment high rate which is found more commonly in high-income economies. In 2009, there is more than 50% of hired workers in Philippines were in services sector as compared to the much more lower to middle income countries such as Indonesia and Thailand which has 12%

and 14% respectively, and a slightly small service sector have an employment of 39% and 41%.

In 2009, only less than 9% was in the manufacturing sector (Palanca-Tan *et al*., 2016). Ubaidillah, Decker, Ab. Rahim, and Ismail (2013) had mentioned that in the Philippines, the industrial production is one of the major sectors that cause environmental pollution such as air pollution and water pollution. Emissions come direct from industrial combined with manufacturing cement and metals, and are not due to the power generation activities of these industries. The Philippines' large service sector and their smaller size manufacturing sector might act as one of the reason for high carbon dioxide emissions found in Philippines (Palanca-Tan *et al*., 2016).

A negative relationship between CO_2 emissions and GDP in agriculture, as the food industries with the other agricultural based industries such as the process of cleaning the coconut, sugar cane and beverages are the major contributing sector of water pollution, which could be explain by the increase in wastes in the Agriculture Sector will increase the CO_2 emissions to be more significant, thus lowering the growth of the economy (Palanca-Tan *et al*., 2016).

2.2.4 Relationship between CO2 and GDP by sectors in Thailand

According to Kisner (2008), agriculture sector plays an interesting role in environmental issue. Agriculture is a benefactor to climate change. For Thailand's agriculture sector, main production for Thailand's economy and culture is rice. Chemical fertilizers used in the production of rice and other crops will contributes to greenhouse gas emissions such as CO_2 emissions and nitrous oxide in an indirect way and lead to climate change. According to Carlsson-Kanyama and Gonzalez (2007), they found that CO_2 emissions are the second higher contributor to climate change while the first and third are instance methane and nitrous oxide. The global increases in methane and nitrous oxide in the atmosphere are primarily due to agriculture. For CO_2 emissions, the main factors that cause CO_2 emissions increasing in Thailand are from weed, residual burning and deforestation. In addition, increases of CO_2 emissions will cause an indirect impact on plant-water relations rather than photosynthesis under heat stress conditions (Kimball, Kobayashi, & Bindi, 2002). According to Sangpenchan (2009), saying that temperatures in 21st century are estimated to increase under continuously increasing of CO_2 emissions. Thus, the natural physical and biological systems such as plant and hydrology are likely to be affected by increasing of CO_2 emissions. For example, Thailand will in a condition of warmer temperature due to CO_2 emissions increasing in sea surface area and plants will change their responsive function as well. They can either gain benefit from or harm by the changes in climate change.

According to Todoc, Todoc, and Lefevre (2005), CO_2 emissions is the main benefactor to greenhouse gases and air pollution in Thailand. During financial crisis period, increasing of CO_2 emissions will occur in transportation and residential and commercial sectors. However, CO_2 emissions will drop in manufacturing sector due to the low level of CO_2 emissions in manufacturing sector than the gross value-added of growth during the financial crisis period. Moreover, according to Aimyuak and Wongsapai (2009, April), saying that CO_2 emissions intensity has powered in manufacturing sector than most of the other sector. Therefore, they have analysed the energy and CO_2 emissions saving in Thailand manufacturing sector by decomposition techniques. From the results, amount of CO_2 emissions has increased that more energy consumption in manufacturing sector while the energy savings in manufacturing sector shows no savings during the period. According to the study results, it showed that CO_2 emissions grew rapidly and the contribution of CO_2 emissions was doubled in manufacturing sector if compare with electricity and transport sector (Criqui, Peytral, & Simon, 2012).

According to Suanmali and Limmeechokchai (2013), transportation sector in Thailand is the biggest energy consuming sector. In order to find out the amount of CO_2 emissions emitted, Input-Output Analysis (IOA) approach will be applied in their study. Results showed that road transportation has the highest CO_2 emissions than the other transportation sector such as trucks, trailers, railways, air, and water transportations. The rising number of vehicles has caused the amount of CO_2 emissions to increase sharply. Increasing of public transportation systems especially the Metropolitan Rapid Transit and Bangkok Mass Transit System in Bangkok were able to reduce and control the CO_2 emissions (Tanatvanit, Limmeechokchai, & Chungpaibulpatana, 2003).

2.2.5 Relationship between CO2 and GDP by sectors in Vietnam

Vietnam is famous in agriculture mainly because of its rice production that contributes to the most of GDP growth. Rice cultivation is also one of the main contributions in the increase in carbon dioxide emissions in Vietnam. Vietnam also belongs to the world’s second largest exporter of rice. Khalil (2009) found that in recent years, nitrogen fertilizers are frequently used in rice agriculture, methane and nitrous oxide are approximately 25% of the global warming that has occurred during the last century, thus increasing carbon dioxide emissions. According to Dinh and Hilmarsson (2014), Vietnam is also famous with seafood and livestock production. Fishing processing industry is more focused and its products are also being exported to markets with high income like United States, Japan, Europe and Australia. Vietnam is also popular with its livestock production. In 2008 alone, Vietnam livestock’s production has more than 3.4 million tons and to grow in fast pace subject to expectation when commercial farms are projected to have more than 300% increment in year 2020 (World Bank, 2009). The higher the production of agriculture products, the more carbon dioxide emissions will be generated, and revenue of economy will follow. This signifies a positive relationship between CO_2 emissions and GDP.

Dinh and Hilmarsson (2014) found that food processing in Vietnam is very important economic development (GDP) but it also bears responsibility to the deterioration in environment (CO_2 emissions). It signifies that both CO_2 emissions and GDP growth has a mutual relationship, it will affect each other if one increases or decreases. If these environmental problems are left unsolved, it may affect the future prospects for industrial growth in Vietnam. Tobacco industry also generates a lot of income for Vietnam. Van Minh, Giang, Bich, and Huong (2009) has found out that even though the cigarette industry might argue that farming of tobacco brings a lot of output growth to the economy in Vietnam, the environmental impacts and health damaging that is caused by it has also been well documented. Tobacco growing has caused a lot of damage to the environment. Geist (1999) also found out that environmental degradation is also caused by the tobacco plant, nutrients which are being leeched from the soil, and also fertilizers and pesticides that are applied to tobacco field that will pollute the environment. All these give rise to the CO_2 emissions, while economic growth also increases.

Vietnam has been recognized as an emerging market for the services sector, especially tourism. Although tourism boosts economic growth, it also contributes to the rising of carbon dioxide emissions. Kusakabe, Shrestha, S. Kumar, and Nguyen (2014, May) found out that Hue City in Vietnam has play an important role in the tourism sector. According to Kusakabe *et al*. (2014, May), the tourism sector alone has approximately contributed 48% of the GDP growth, revenues that is obtained from the service sector. However, because of the improvement in tourism sector, carbon dioxide emissions also increase. This means positive relationship occurs between economic growth and carbon dioxide emissions. Freight, travel, infrastructure and assets are the biggest sources of carbon dioxide emissions. Garden house promotion is to be implemented at Hue City to promote eco-tourism. For example, use of bicycles and small boats to take tourists' places to places. Even though the main objective is to increase number of tourists, it also can help reduce carbon dioxide emissions.

2.3 Conclusion

In short, it is important that these hypothesis methods are being carried out since we can find out how CO_2 emissions will Granger cause GDP and vice versa, whether there is a positive, negative, how it will affect each other or there is no relationship between each other. Finding out the relationship between CO_2 emissions and GDP in each different sectors is also crucial, because the sectors that produces a lot of CO_2 emissions can be pinpointed, and the responsible parties can devise ways or methods to promote economic growth while at the same time reduce carbon dioxide emissions, to shape a clean environment for all people to live in.

CHAPTER 3: METHODOLOGY

3.0 Introduction

We will be discussed about the econometric techniques and data description. Data description is the outline of the variables that we had used and the data resources obtained in this study. Carbon dioxide (CO_2) emissions and economic growth (GDP) of 3 sectors (agriculture, manufacturing, services) from the 5 selected ASEAN countries will be clearly described in this chapter and also the relationship between them. The sample size that used to examine for this study is 31 years which is from the years 1983-2013. Due to the different measurement unit is included in our data, so Logarithm is added in to the equation with the purpose of linearize and simplify the relationship in the model. Moreover, unit root test (Augmented Dickey-Filler) and Autoregressive Distributed Lag (ARDL) approach also used in this chapter in order to eliminate econometric problems and bias issues.

3.1 Data Description

The variables (sector) have been chosen for this study are agriculture (AGR), manufacturing (MAN) and service (SER). To determine the relationship of CO_2 emissions and GDP of the sectors in each country, the econometric model is developed as follow.

3.1.1 Econometric Model

$$CO2_i = f(\,AGR_i, MAN_i, SER_i)$$

while i represent Indonesia (IND), Malaysia (MYS), Philippine (PHL), Thailand (THA) and Vietnam (VNM).

Written in specific form:

$$logCO2_{IND} = \alpha_0 + \alpha_1 logAGR_{IND} + \alpha_2 logMAN_{IND} + \alpha_3 logSER_{IND} + \varepsilon_{1t}$$

$$logCO2_{MYS} = \alpha_0 + \alpha_1 logAGR_{MYS} + \alpha_2 logMAN_{MYS} + \alpha_3 logSER_{MYS} + \varepsilon_{1t}$$

$$logCO2_{PHL} = \alpha_0 + \alpha_1 logAGR_{PHL} + \alpha_2 logMAN_{PHL} + \alpha_3 logSER_{PHL} + \varepsilon_{1t}$$

$$logCO2_{THA} = \alpha_0 + \alpha_1 logAGR_{THA} + \alpha_2 logMAN_{THA} + \alpha_3 logSER_{THA} + \varepsilon_{1t}$$

$$logCO2_{VNM} = \alpha_0 + \alpha_1 logAGR_{VNM} + \alpha_2 logMAN_{VNM} + \alpha_3 logSER_{VNM} + \varepsilon_{1t}$$

3.1.2 Sources of Data and Definitions

<u>Table 3.1 Summary of Variable and Data Sources</u>

Variables	Indicator of variable	Unit measurement	Source of data
Carbon Dioxide Emissions	LNCO2	Kiloton (kt)	World Bank Indicator, and Carbon Dioxide Information Analysis Center
Gross Domestic Product (Agriculture)	LNAGR	Current Local Currency Unit (LCU)	World Bank Indicator
Gross Domestic Product (Manufacturing)	LNMAN	Current Local Currency Unit (LCU)	World Bank Indicator

Gross Domestic Product (Service)	LNSER	Current Local Currency Unit (LCU)	World Bank Indicator

3.1.3 Variables and Measurement

3.1.3.1 Carbon Dioxide (CO_2) Emissions

Carbon dioxide is a heat-trapping greenhouse gas which is odourless and colourless. Increasing of CO_2 emissions will tend to lead to a greater global warming and climate change as it is due from burn of fossil fuels such as coal, oil, and natural gas; and when during combustion, the same energy level used for different fossil fuels releases different amounts of CO_2 emissions in the air. It will include driving of cars, used of electricity and also thru cement producing (WorldBank, 2010b). CO_2 emissions has a unit measurement of kiloton (kt) and the data was collected from World Bank Indicator and Carbon Dioxide Information Analysis Center in the period of 31 years from year 1983 to year 2013.

3.1.3.2 Gross Domestic Product (Agriculture)

Agriculture sector in GDP often refers to forestry, apparel and tobacco manufacturing, and livestock production and related activities which will contribute to the GDP of the country (WorldBank, 2010a). The unit measurement for GDP agriculture is current Local Currency Unit (LCU). Agriculture GDP data was collected from year 1983 to year 2013 from World Bank Indicator for the period of 31 years.

3.1.3.3 Gross Domestic Product (Manufacturing)

Manufacturing sector is measured by the unit measurement of current Local Currency Unit (LCU) and in the period of 31 years from year 1983 to year 2013. Data was collected from the World Bank Indicator. Manufacturing is the largest segment of the economy. Manufacturing are helping to stimulate the country thru earnings and exports as it helps in the increase on developing a more advanced manufacturing skills by taking in advanced infrastructure and technologies and also by giving more proper manufacturing education and training. Manufacturing can be also defined as the production of goods which can be made to increase GDP (WorldBank, 2010c).

3.1.3.4 Gross Domestic Product (Services)

Services in GDP are defined as the production of which it will contribute to the service which involves servicing to earn a profit such as government contribution, transportation, construction, restaurant, trade, financing, insurance, real estate and social and personal services. Increments in income will lead to the growth and an increase in the service sector as personal incomes and consumption in the services sector has an affectively positive relationship. The consumption behaviour may influence the service sector as the higher the income the more service will be produced (WorldBank, 2010d). GDP services sector is measured by current Local Currency Unit (LCU) and data was collected for the period of 31 years from year 1983 to year 2013 from the World Bank Indicator.

3.2 Econometric Methods

This research is being experimented on by applying time series methods. The function of time series methods allows us the flexibility to make a forecast and making estimation on the research model. The purpose of the research is to determine the dynamic relationship between the energy use, CO_2 emissions, and economic growth. In this case, since short run relationship and long run relationship of the variables needs to be finding out, we use ADRL approach and ADF approach.

3.2.1 Augmented Dickey-Fuller (ADF)

Augmented Dickey-Fuller (ADF) is a unit root test found in the model of autoregressive according to Greene (1997), the simplest method to test unit root test and used to check whether there is problem occur in statistical inference in time series form.

The test statistic formula is as follow:

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

The null hypotheses are as follow:

H_0: Data needs to be differenced to make it stationary.

H_1: Data does not need to be differenced if it is stationary.

Null hypothesis will be rejected if the significant level is higher than the probability value (p-value), and when the data is stationary.

After reaching stationary level, the study can move on to the next step by performing diagnostic checking.

3.2.2 Akaike Information Criterion (AIC)

According to Moffatt (2017), AIC is developed by Professor Hirotugu Akaike in 1971 and proposed in year 1974. It is usually attempted to measure the quality of an econometric model and also used for selecting the best model among the nested econometric model. The econometrics term of AIC is as followed:

$$AIC = -2L_m + 2m \text{ or } AIC = T \ln(RSS) + 2m$$

Where,

L_m = the maximized *log-likelihood*

m = the number of parameters in the model.

T = the number of observation

RSS = residual sum of squares

According to Everitt and Skrondal (1998), AIC consider of both statistical goodness of fit and the parameters should be estimated to increase to meet the degree of fit. After that, the model which has lower value of AIC is more preferable due to the lowest value indicates that it has few parameters and will provide an adequate fit to the data.

Besides that, AIC showed how well the model fits to its observations or data and this criterion helped the researchers to prevent over choice of parameters.

3.2.3 Autoregressive Distributed Lag model (ARDL)

This technique is recommended by Pesaran, Shin, and Smith (2001) due to it is the most appropriate method to estimate the relationship between CO2 emission and GDP by sectors. This is because it is more efficient in small sample size which is matched with this study. By using this method, estimated parameters and standard errors are efficient and unbiased. Besides that, the coefficients can be estimated in long run and short run by using consistent evaluation. An advantage of using ARDL approach due to it is easier to interpret and implement, and various type of variables can have different lengths of the lag due to the small sample size data (Pesaran *et al.*, 2001).

The basic form for ARDL model is as follow:

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

To test for cointegration (long run relationship exists), Unrestricted Error Correction Model is being constructed as follow:

$$\Delta CO2_{IND_t} = \theta_1 + \sum_{i=1}^{k1} \gamma_{1i}\, \Delta CO2_{IND_{t-1}} + \sum_{i=0}^{k2} \gamma_{2i}\, \Delta AGR_{IND_t} + \sum_{i=0}^{k3} \gamma_{3i}\, \Delta MAN_{IND_t} + \sum_{i=0}^{k4} \gamma_{4i}\, \Delta SER_{IND_t} + \beta_0 CO2_{IND_{t-1}} + \beta_1 AGR_{IND_{t-1}} + \beta_2 MAN_{IND_{t-1}} + \beta_3 SER_{IND_{t-1}} + \varepsilon_t$$

$$\Delta CO2_{MYS_t} = \theta_1 + \sum_{i=1}^{k1} \gamma_{1i}\, \Delta CO2_{MYS_{t-1}} + \sum_{i=0}^{k2} \gamma_{2i}\, \Delta AGR_{MYS_t} + \sum_{i=0}^{k3} \gamma_{3i}\, \Delta MAN_{MYS_t} + \sum_{i=0}^{k4} \gamma_{4i}\, \Delta SER_{MYS_t} + \beta_0 CO2_{MYS_{t-1}} + \beta_1 AGR_{MYS_{t-1}} + \beta_2 MAN_{MYS_{t-1}} + \beta_3 SER_{MYS_{t-1}} + \varepsilon_t$$

$$\Delta CO2_{PHL_t} = \theta_1 + \sum_{i=1}^{k1} \gamma_{1i}\, \Delta CO2_{PHL_{t-1}} + \sum_{i=0}^{k2} \gamma_{2i}\, \Delta AGR_{PHL_t} + \sum_{i=0}^{k3} \gamma_{3i}\, \Delta MAN_{PHL_t} + \sum_{i=0}^{k4} \gamma_{4i}\, \Delta SER_{PHL_t} + \beta_0 CO2_{PHL_{t-1}} + \beta_1 AGR_{PHL_{t-1}} + \beta_2 MAN_{PHL_{t-1}} + \beta_3 SER_{PHL_{t-1}} + \varepsilon_t$$

$$\Delta CO2_{THA_t} = \theta_1 + \sum_{i=1}^{k1} \gamma_{1i}\, \Delta CO2_{THA_{t-1}} + \sum_{i=0}^{k2} \gamma_{2i}\, \Delta AGR_{THA_t} + \sum_{i=0}^{k3} \gamma_{3i}\, \Delta MAN_{THA_t} + \sum_{i=0}^{k4} \gamma_{4i}\, \Delta SER_{THA_t} + \beta_0 CO2_{THA_{t-1}} + \beta_1 AGR_{THA_{t-1}} + \beta_2 MAN_{THA_{t-1}} + \beta_3 SER_{THA_{t-1}} + \varepsilon_t$$

$$\Delta CO2_{VNM_t} = \theta_1 + \sum_{i=1}^{k1} \gamma_{1i}\, \Delta CO2_{VNM_{t-1}} + \sum_{i=0}^{k2} \gamma_{2i}\, \Delta AGR_{VNM_t} + \sum_{i=0}^{k3} \gamma_{3i}\, \Delta MAN_{VNM_t} + \sum_{i=0}^{k4} \gamma_{4i}\, \Delta SER_{VNM_t} + \beta_0 CO2_{VNM_{t-1}} + \beta_1 AGR_{VNM_{t-1}} + \beta_2 MAN_{VNM_{t-1}} + \beta_3 SER_{VNM_{t-1}} + \varepsilon_t$$

The null hypothesis is being expressed as below:

$$H_0 : \beta_0 = \beta_1 = \beta_2 = \beta_3 = 0$$
$$H_1 : \beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$$

The null hypothesis means there will be no cointegration among the variables. According to Pesaran *et al*. (2001), hypothesis statement which is non-standard asymptotic distribution will be tested with F-statistics. There are two set of critical value given where one set assumes all that variables are I(0) and the other set will be I(1), giving a bound that covered all potential classification of variables into I(0) and I(1). After the F-statistic is being formulated and computed, then there being compared with the upper and lower bound critical value.

$\mathbf{F_{statistic}}$ **< Lower Critical Bound** = H_0 is not rejected, no long run relationship exist.

$\mathbf{F_{statistic}}$ **> Upper Critical Bound** = H_0 is rejected, long run relationship exist.

Lower Critical Bound >$\mathbf{F_{statistic}}$ **< Upper Critical Bound** = inconclusive.

After the co-integration has been established, the ARDL conditional long run model can be estimated as:

$$CO2_{IND_t} = \theta_2 + \sum_{i=1}^{k1} \vartheta_{1i}\, CO2_{IND_{t-1}} + \sum_{i=0}^{k2} \vartheta_{2i}\, AGR_{IND_t} + \sum_{i=0}^{k3} \vartheta_{3i}\, MAN_{IND_t} + \sum_{i=0}^{k4} \vartheta_{4i}\, SER_{IND_t} + \varepsilon_t$$

$$CO2_{MYS_t} = \theta_2 + \sum_{i=1}^{k1} \vartheta_{1i}\, CO2_{MYS_{t-1}} + \sum_{i=0}^{k2} \vartheta_{2i}\, AGR_{MYS_t} + \sum_{i=0}^{k3} \vartheta_{3i}\, MAN_{MYS_t} + \sum_{i=0}^{k4} \vartheta_{4i}\, SER_{MYS_t} + \varepsilon_t$$

$$CO2_{PHL_t} = \theta_2 + \sum_{i=1}^{k1} \vartheta_{1i}\, CO2_{PHL_{t-1}} + \sum_{i=0}^{k2} \vartheta_{2i}\, AGR_{PHL_t} + \sum_{i=0}^{k3} \vartheta_{3i}\, MAN_{PHL_t} + \sum_{i=0}^{k4} \vartheta_{4i}\, SER_{PHL_t} + \varepsilon_t$$

$$CO2_{THA_t} = \theta_2 + \sum_{i=1}^{k1} \vartheta_{1i}\, CO2_{THA_{t-1}} + \sum_{i=0}^{k2} \vartheta_{2i}\, AGR_{THA_t} + \sum_{i=0}^{k3} \vartheta_{3i}\, MAN_{THA_t} + \sum_{i=0}^{k4} \vartheta_{4i}\, SER_{THA_t} + \varepsilon_t$$

$$CO2_{VNM_t} = \theta_2 + \sum_{i=1}^{k1} \vartheta_{1i}\, CO2_{VNM_{t-1}} + \sum_{i=0}^{k2} \vartheta_{2i}\, AGR_{VNM_t} + \sum_{i=0}^{k3} \vartheta_{3i}\, MAN_{VNM_t} + \sum_{i=0}^{k4} \vartheta_{4i}\, SER_{VNM_t} + \varepsilon_t$$

In the last step, Error Correction Model (ECM) will be applied. ECM is used to form the short run model by setting up error correction term which related to long run estimators and it is specified as follow:

$$\Delta CO2_{IND_t} = \theta_3 + \sum_{i=1}^{k1} \varphi_{1i}\, \Delta CO2_{IND_{t-1}} + \sum_{i=0}^{k2} \varphi_{2i}\, \Delta AGR_{IND_t} + \sum_{i=0}^{k3} \varphi_{3i}\, \Delta MAN_{IND_t} + \sum_{i=0}^{k4} \varphi_{4i}\, \Delta SER_{IND_t} + \delta ecm_{t-1}$$

$$\Delta CO2_{MYS_t} = \theta_3 + \sum_{i=1}^{k1} \varphi_{1i}\, \Delta CO2_{MYS_{t-1}} + \sum_{i=0}^{k2} \varphi_{2i}\, \Delta AGR_{MYS_t} + \sum_{i=0}^{k3} \varphi_{3i}\, \Delta MAN_{MYS_t} + \sum_{i=0}^{k4} \varphi_{4i}\, \Delta SER_{MYS_t} + \delta ecm_{t-1}$$

$$\Delta CO2_{PHL_t} = \theta_3 + \sum_{i=1}^{k1} \varphi_{1i}\, \Delta CO2_{PHL_{t-1}} + \sum_{i=0}^{k2} \varphi_{2i}\, \Delta AGR_{PHL_t} + \sum_{i=0}^{k3} \varphi_{3i}\, \Delta MAN_{PHL_t} + \sum_{i=0}^{k4} \varphi_{4i}\, \Delta SER_{PHL_t} + \delta ecm_{t-1}$$

$$\Delta CO2_{THA_t} = \theta_3 + \sum_{i=1}^{k1} \varphi_{1i}\, \Delta CO2_{THA_{t-1}} + \sum_{i=0}^{k2} \varphi_{2i}\, \Delta AGR_{THA_t} + \sum_{i=0}^{k3} \varphi_{3i}\, \Delta MAN_{THA_t} + \sum_{i=0}^{k4} \varphi_{4i}\, \Delta SER_{THA_t} + \delta ecm_{t-1}$$

$$\Delta CO2_{VNM_t} = \theta_3 + \sum_{i=1}^{k1} \varphi_{1i}\, \Delta CO2_{VNM_{t-1}} + \sum_{i=0}^{k2} \varphi_{2i}\, \Delta AGR_{VNM_t} + \sum_{i=0}^{k3} \varphi_{3i}\, \Delta MAN_{VNM_t} + \sum_{i=0}^{k4} \varphi_{4i}\, \Delta SER_{VNM_t} + \delta ecm_{t-1}$$

Where, φ_{1i}, φ_{2i}, φ_{3i}, and φ_{4i} are the short run parameters of the model and δ is the speed of adjustment. The speed of adjustment showed how much adjustment needed in order to reach the long run equilibrium.

3.3 Diagnostic Checking

3.3.1 Auto-Regressive Conditional Heteroscedasticity (ARCH) Test

According to Engle (2001), in order to analyse and forecast volatility, ARCH and Generalized ARCH (GARCH) have become useful tools in the analysis of time series data. Besides that, from the perspective of econometric inference, ignoring ARCH may lead to arbitrarily large loss in asymptotic efficiency and will cause over rejection of standard tests for serial correlation in conditional mean (Hong & Shehadeh, 1999). In addition, as from Bera and Higgins (1993), the ARCH model is practical as it not only catches useful facts, and also applications to numerous and diverse areas. Not only that, in their study; it has been implemented in asset pricing to test the I-CAPM, the CAAPM, the APT, and the CCAPM. Moreover, according to Wang, Van Gelder, Vrijling, and Ma (2005), ARCH-type model is a nonlinear model which takes into account of the past variances in the explanation for the future variances. This type of model can produce a more accurate forecast of future volatility, especially over a short horizon. ARCH-type models take into account excess kurtosis, which is common in hydrologic processes therefore they might come in handy for hydrologic time series modelling (Wang *et al*., 2005).

There is evidence to reject the null hypothesis if the test statistic exceeds the critical value from a chi-square distribution with q degrees of freedom as compared with the null hypothesis of no existence of ARCH error versus the alternative hypothesis which that the conditional error variance is given by an ARCH (q) process.

3.3.2 Breusch-Godfrey LM Test

According to Baum, Schaffer, and Stillman (2007), Breusch and Godfrey proposed that the LM test can be applied to ordinary least square (OLS) regressions. According to Gujarati and Dawn (2009), Durbin-Watson and Durbin’s h test have the same features as Breusch-Godfrey LM test do, but LM test marks an important note that the lagged dependent variables and serial correlation have to be in higher level. Breusch-Godfrey Serial Correlation LM test imply to find out autocorrelation problem. Null hypothesis will be free from autocorrelation problem whereas, alternative hypothesis will be stated to have an autocorrelation problem. If result shows the p-value is less than the significant level, the null hypothesis will be rejecting and can conclude that model consists of autocorrelation problem. When autocorrelation problem occurred, it means that the estimated parameter tends to be unbiased, inefficient and consistent therefore, no longer Best Linear Unbiased Estimators (BLUE).

3.3.3 Jarque-Bera (JB) Test

According to Razali and Yap (2011), JB test in under moment test which is from D'Agostino and Stephens (1986) but as according to Chen and Kuan (2003), JB test known as a popular diagnostic tool in practice and is usually applied to various general models, for example the conditional heteroscedasticity models and the nonlinear regressions. According to UI-Islam (2011), most of the inferential procedures used are based on the normality of error terms assumption of the linear regression models. It is stated that the normality is one of the assumptions for many statistical tests such as F-test or t-test. Therefore, any diagnostic tests made from regression models related to the normality are equally important for validating inferences. JB test is usually run before one of the statistical tests to confirm normality and it is normally used for larger data size as other normality tests are not fully reliable for example Shapiro-Wilk tests.

The null hypothesis (H_0) for the test is that the error term is normally distributed while the alternate hypothesis (H_1) is that the error term is not normally distributed. In general, a large JB value indicates that errors are not normally distributed. Therefore, in decision, we have to reject null hypothesis and the model does not meet the normality assumption on the error term.

3.3.4 Ramsey RESET Test

According to Wooldridge (2002, pp. 124-125), Ramsey's regression error specification (RESET) test known as omitted variables test but work well when interpreting the model in functional form with running of neglected nonlinearities test. Besides, the RESET test will only work well when there is implementation of using "forecast value" according to Baum *et al*. (2007). Ramsey RESET test is the stability test that needed to test for model specification bias to detect whether inappropriate variables been included that causes problem and irrelevant results. Null hypothesis will be stated the model is specified correctly and whereas, alternative hypothesis will be stated the model is not specified correctly. If result shows p-value greater than significant level, means null hypothesis will not be reject, interpreted the model specification is correct.

3.4 Conclusion

Chapter 3 has discussed all the characteristics of all variables that had chosen for this study. Moreover, there are 2 econometric method is used which are ADF and ARDL approach. ADF is to examine the variables' stationary while ARDL used to define the short-run and long-run relationship between CO_2 emissions and GDP by sectors. Other than that, the feature of 4 types of diagnostic checking test also has been discussed. The 4 tests mentioned which are Auto-Regressive Conditional Heteroscedasticity (ARCH) Test, Breusch-Godfrey LM Test, Jarque-Bera (JB) Test, and Ramsey RESET Test. These tests are going to be used in chapter 4 to ensure that the model is free from the economics problem.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

The results of short run and long run relationship between CO_2 emissions and GDP by sector in agriculture, manufacturing, and services will be further explained and discussed in this chapter.

4.1 Unit Root Test

Commonly unit root tests are from the Augmented Dickey–Fuller (ADF), it comes with power if least square is used to deter the time series. As lag selection was focus on this model and has a correct size due to there is enough lags are included, deterministic components from the model has to be excluded and an alternative approach to determine lag length will be the hypothesis testing which uses lags that are significantly coefficient **(**Cavaliere, Phillips, Smeekes, & Taylor, 2015). Since the test have higher reaction to the lag that being introduced with the first differential variables according to Saboori, Sulaiman, and Mohd (2012), 4 orders has been tested to find the best fit.

Lag 4 has been chosen as the best result to explain the relationship existing between CO_2 emissions and GDP by sectors in Indonesia and Malaysia. In addition, lag 1 has been chosen as the best result to explain the relationship existing between CO_2 emissions and GDP by sectors in Philippines and Vietnam. Meanwhile, lag 3 has been chosen as the best result to explain the relationship existing between CO_2 emissions and GDP by sectors in Thailand.

4.1.1 Augmented Dickey-Filler Unit Root Test for the variables in Indonesia

Table 4.1 Result of Augmented Dickey-Filler Unit Root Test for the variables in Indonesia (Lag 4).

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
LNCO2	-1.068381 (0.7149)	-5.300824 (0.0002)**
LNAGR	-0.186005 (0.9287)	-3.846593 (0.0075)**
LNMAN	-3.113622 (0.0379)	-3.131646 (0.0370)**
LNSER	-0.246679 (0.9202)	-5.818059 (0.0001)**
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.		

4.1.2 Augmented Dickey-Filler Unit Root Test for the variables in Malaysia

Table 4.2 Result of Augmented Dickey-Filler Unit Root Test for the variables in Malaysia (Lag 4).

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
LNCO2	-0.972860 (0.7499)	-5.360786 (0.0001)**
LNAGR	-0.029321 (0.9484)	-5.504270 (0.0001)**
LNMAN	-1.542893 (0.4986)	-4.212921 (0.0027)**
LNSER	0.121029 (0.9621)	-4.485359 (0.0013)**
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.		

4.1.3 Augmented Dickey-Filler Unit Root Test for the variables in Philippines

Table 4.3 Result of Augmented Dickey-Filler Unit Root Test for the variables in Philippines (Lag 1).

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
LNCO2	-0.323946 (0.9098)	-4.892056 (0.0005)**
LNAGR	-2.841539 (0.0645)	-8.482059 (0.0000)**
LNMAN	-2.975526 (0.0488)	-7.250210 (0.0000)**
LNSER	-3.716195 (0.0089)	-5.647750 (0.0001)**
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.		

4.1.4 Augmented Dickey-Filler Unit Root Test for the variables in Thailand

Table 4.4 Result of Augmented Dickey-Filler Unit Root Test for the variables in Thailand (Lag 3).

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
LNCO2	-3.158636 (0.0328)	-2.954502 (0.0514)*
LNAGR	0.358789 (0.9776)	-5.757895 (0.0000)*
LNMAN	-3.278794 (0.0251)	-3.372135 (0.0205)*
LNSER	-2.055165 (0.2632)	-2.683806 (0.0890)*
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.		

4.1.5 Augmented Dickey-Filler Unit Root Test for the variables in Vietnam

Table 4.5 Result of Augmented Dickey-Filler Unit Root Test for the variables in Vietnam (Lag 1).

Variables	ADF	
	Level form	1st difference
	Trend and Intercept	Intercept
LNCO2	0.174961 (0.9662)	-3.559968 (0.0136)*
LNAGR	-9.419671 (0.0000)	-2.828899 (0.0675)*
LNMAN	-10.24242 (0.0000)	-3.529227 (0.0149)*
LNSER	-0.074818 (0.9420)	-14.21255 (0.0000)*
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.		

4.2 Result of Diagnostic Checking

In this chapter, diagnostic checking such as ARCH test, Serial Correlation LM test, Jarque-Bera normality test, Ramsey RESET test, CUSUM and CUSUM square test were carried out in order to make sure that the model is free from economic problems.

4.2.1 Diagnostic Checking for CO2 emissions and GDP by sectors in Indonesia

Table 4.6 Result of Diagnostic Checking for CO_2 emissions and GDP by sectors in Indonesia.

Diagnostic Testing	Chi-Square / F-Statistic	P-value	Conclusion
ARCH Test	2.860982	0.0908	No Heteroscedasticity Problem
Serial Correlation LM Test	1.022934	0.5996	No Autocorrelation Problem
Jarque-Bera (Normality Test)	1.948712	0.377435	Error Term Normally Distributed
Ramsey RESET Test (Stability Test)	2.944637	0.1009	Model Correctly Specified
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

To test for the heteroscedasticity problem, the ARCH test been applied as time series analysis was used. There will be a heteroscedasticity problem when the p-value is less than 1% significant level. Table 4.6 shows the p-value (0.0908) of ARCH test is greater than 1% significant level, therefore the study conclude that there is no heteroscedasticity problem.

Moreover, the Breusch-Godfrey Serial Correlation LM test was used to uncover whether there is an autocorrelation problem. There will be an autocorrelation problem if the p-value is less than 1% significant level. As from result shown in Table 4.6, the p-value (0.5996) is greater than 1% significant level, the study draws to a close that there is no autocorrelation problem.

Last but not least, Ramsey RESET test (stability test) and Jarque-Bera test which is the normality test and were needed to test for model specification bias. The error term is not normally distributed and stability test is unstable if the p-value is less than 1% significant level. Since the result from Jarque-Bera test shows that the p-value (0.377435) is greater than 1% significant level, do not reject null hypothesis. Thus, the study concludes that the error term is normally distributed. For Ramsey RESET test, the result shows that the p-value (0.1009) is greater than 1% significant level, do not reject null hypothesis. The study concludes that the model is proven as correctly specified. As a result, the t-test and F-test will be valid, and the model follows normal distribution.

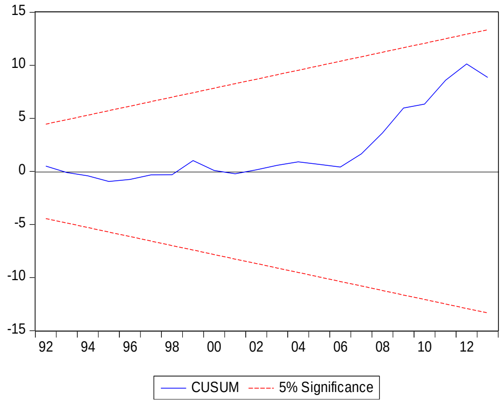


Figure 4.1: CUSUM Test

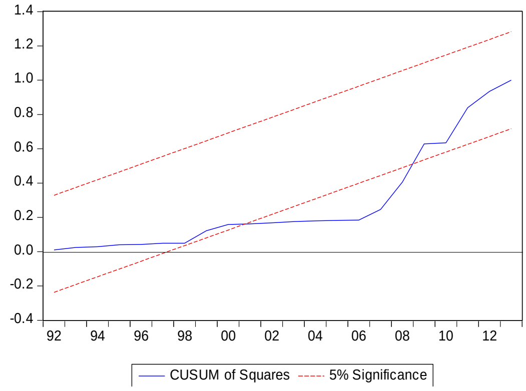


Figure 4.2: CUSUM Square Test

Figure 4.1 showed the coefficient is stable, as the plot of CUSUM falls within the range of 5% significant level. Figure 4.2 showed the coefficient is unstable, as the plot of CUSUMSQ falls beyond the range of 5% significant level. The reason behind might be due to the financial crisis happened throughout the period.

4.2.2 Diagnostic Checking for CO2 emissions and GDP by sectors in Malaysia

Table 4.7 Result of Diagnostic Checking for CO_2 emissions and GDP by sectors in Malaysia.

Diagnostic Testing	Chi-Square / F-Statistic	P-value	Conclusion
ARCH Test	2.715916	0.0994	No Heteroscedasticity Problem
Serial Correlation LM Test	10.85171	0.0044***	There is an Autocorrelation Problem
Jarque-Bera (Normality Test)	2.715445	0.257246	Error Term Normally Distributed
Ramsey RESET Test (Stability Test)	15.50169	0.0006***	Model is not Correctly Specified

Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.

To test for the heteroscedasticity problem, the ARCH test been applied as time series analysis was used. There will be a heteroscedasticity problem when the p-value is less than 1% significant level. Table 4.7 shows the p-value (0.0994) of ARCH test is greater than 1% significant level, therefore the study draws to a close that there is no heteroscedasticity problem.

Next, the Breusch-Godfrey Serial Correlation LM test was used to uncover whether there is an autocorrelation problem. There will be an autocorrelation problem if the p-value is less than 1% significant level. As from the result shown in Table 4.7, the p-value (0.0044) is less than 1% significant level, the study conclude that there is an autocorrelation problem. Since autocorrelation problem occurs, it means that the estimated parameter is unbiased, inefficient and consistent and therefore no longer is Best Linear Unbiased Estimators (BLUE). Therefore, the Newey-West test was carried out to solve the autocorrelation problem.

In addition, after applied Newey-West test to solve autocorrelation problem, Jarque-Bera test (normality test) and Ramsey RESET test (stability test) were needed to test for model specification bias. The error term is not normally distributed and stability test is unstable if the p-value is less than 1% significant level. Since the result from Jarque-Bera test shows that the p-value (0.257246) is greater than 1% significant level, do not reject null hypothesis. Thus, the study concludes that the error term is normally distributed. For the Ramsey RESET test will be another way round, the result shows that the p-value (0.0006) is less than 1% significant level, reject null hypothesis. The study concludes that the model is not correctly specified. Thus, the t-test and F-test no longer valid and the model do not follow a normal distribution.

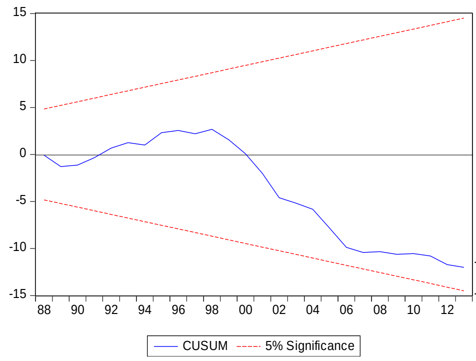


Figure 4.3: CUSUM Test

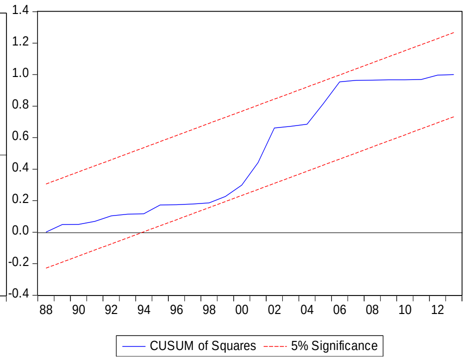


Figure 4.4: CUSUM Square Test

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

4.2.3 Diagnostic Checking for CO2 emissions and GDP by sectors in Philippines

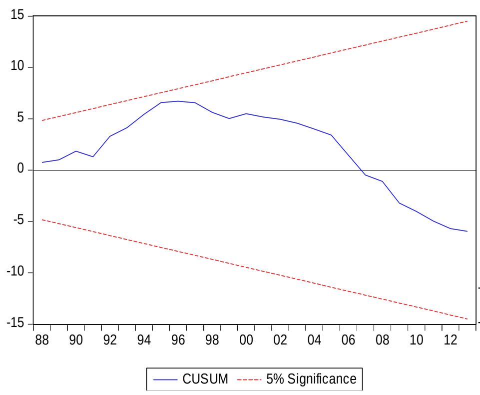
Table 4.8 Result of Diagnostic Checking for CO_2 emissions and GDP by sectors in Philippines.

Diagnostic Testing	**Chi-Square / F-Statistic**	**P-value**	**Conclusion**
ARCH Test	5.660524	0.0174	No Heteroscedasticity Problem
Serial Correlation LM Test	15.62073	0.0004***	There is an Autocorrelation Problem
Jarque-Bera (Normality Test)	1.450039	0.484315	Error Term Normally Distributed
Ramsey RESET Test (Stability Test)	14.01112	0.0010***	Model is not Correctly Specified
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

To test for the heteroscedasticity problem, the ARCH test been applied as time series analysis was used. There will be a heteroscedasticity problem when the p-value is less than 1% significant level. Table 4.8 shows the p-value (0.0174) of ARCH test is greater than 1% significant level, therefore the study conclude that there is no heteroscedasticity problem.

In additionally, the Breusch-Godfrey Serial Correlation LM test was used to uncover whether there is an autocorrelation problem. There will be an autocorrelation problem if the p-value is less than 1% significant level. As from the result shown in Table 4.8, the p-value (0.0004) is less than 1% significant level, the study draws to a close that there is an autocorrelation problem. Since autocorrelation problem occurs, it means that the estimated parameter is unbiased, inefficient and consistent and therefore no longer is Best Linear Unbiased Estimators (BLUE). Therefore, the Newey-West test was carried out to solve the autocorrelation problem.

Last but not least, after applied Newey-West test to solve autocorrelation problem, Jarque-Bera test (normality test) and Ramsey RESET test (stability test) were needed to test for model specification bias. The error term is not normally distributed and stability test is unstable if the p-value is less than 1% significant level. Since the result from Jarque-Bera test shows that the p-value (0.484315) is greater than 1% significant level, do not reject null hypothesis. Thus, the study concludes that the error term is normally distributed. For the Ramsey RESET test will be another way round, the result shows that the p-value (0.0010) is less than 1% significant level, reject null hypothesis. The study concludes that the model is not correctly specified. Thus, the t-test and F-test no longer valid and the model do not follow a normal distribution.



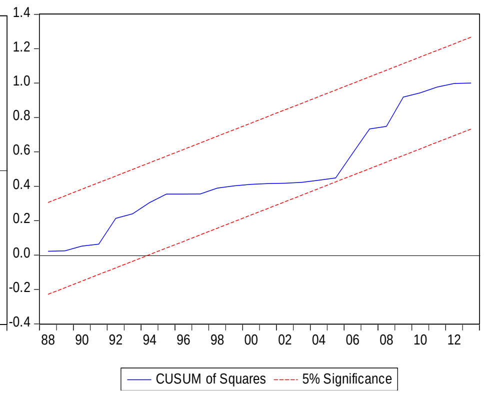


Figure 4.5: CUSUM Test **Figure 4.6 CUSUM Square Test**

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

4.2.4 Diagnostic Checking for CO2 emissions and GDP by sectors in Thailand

Table 4.9 Result of Diagnostic Checking for CO_2 emissions and GDP by sectors in Thailand.

Diagnostic Testing	Chi-Square / F-Statistic	P-value	Conclusion
ARCH Test	0.005654	0.9401	No Heteroscedasticity Problem
Serial Correlation LM Test	8.872028	0.0118	No Autocorrelation Problem
Jarque-Bera (Normality Test)	0.723336	0.696514	Error Term Normally Distributed
Ramsey RESET Test (Stability Test)	3.284343	0.0820	Model Correctly Specified
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

To test for the heteroscedasticity problem, the ARCH test been applied as time series analysis was used. There will be a heteroscedasticity problem when the p-value is less than 1% significant level. Table 4.9 shows the p-value (0.9401) of ARCH test is greater than 1% significant level, therefore the study conclude that there is no heteroscedasticity problem.

Moreover, the Breusch-Godfrey Serial Correlation LM test was used to uncover whether there is an autocorrelation problem. There will be an autocorrelation problem if the p-value is less than 1% significant level. As from the result shown in Table 4.9, the p-value (0.0118) is greater than 1% significant level, the study draws to a close that there is no autocorrelation problem.

Furthermore, Jarque-Bera test (normality test) and Ramsey RESET test (stability test) were needed to test for model specification bias. The error term is not normally distributed and stability test is unstable if the p-value is less than 1% significant level. Since the result from Jarque-Bera test shows that the p-value (0.696514) is greater than 1% significant level, do not reject null hypothesis. Thus, the study concludes that the error term is normally distributed. For the Ramsey RESET test will be another way round, the result shows that the p-value (0.0820) is greater than 1% significant level, do not reject null hypothesis. The study concludes that the model is correctly specified. As a result, the t-test and F-test will be valid, and the model follows normal distribution.

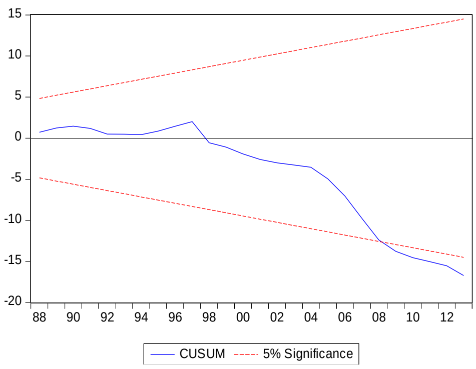


Figure 4.7: CUSUM Test

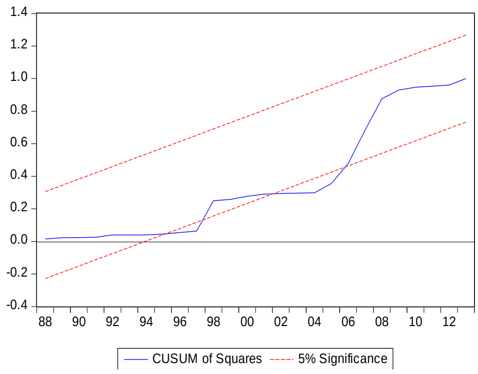


Figure 4.8: CUSUM Square Test

Figure 4.7 and Figure 4.8 showed the coefficients are unstable, as the plot of CUSUM and CUSUMSQ falls beyond the range of 5% significant level. The reason behind might be due to the financial crisis happened throughout the period.

4.2.5 Diagnostic Checking for CO2 emissions and GDP by sectors in Vietnam

Table 4.10 Result of Diagnostic Checking for CO_2 emissions and GDP by sectors in Vietnam.

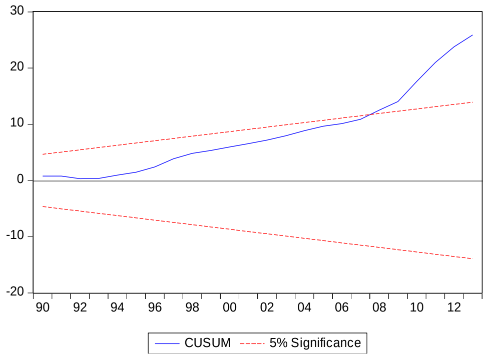
Diagnostic Testing	Chi-Square / F-Statistic	P-value	Conclusion
ARCH Test	7.845964	0.0051***	There is Heteroscedasticity Problem
Serial Correlation LM Test	17.64662	0.0001***	There is an Autocorrelation Problem
Jarque-Bera (Normality Test)	1.960440	0.375228	Error Term Normally Distributed
Ramsey RESET Test (Stability Test)	6.102473	0.0213	Model Correctly Specified

Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.

To test for the heteroscedasticity problem, the ARCH test been applied as time series analysis was used. There will be a heteroscedasticity problem when the p-value is less than 1% significant level. Table 4.10 shows the p-value (0.0051) of ARCH test is less than 1% significant level, therefore the study conclude that there is heteroscedasticity problem.

Then, the Breusch-Godfrey Serial Correlation LM test was used to uncover whether there is an autocorrelation problem. There will be an autocorrelation problem if the p-value is less than 1% significant level. As from the result shown in Table 4.10, the p-value (0.0001) is less than 1% significant level, the study draws to a close that there is an autocorrelation problem. Since autocorrelation problem occurs, it means that the estimated parameter is unbiased, inefficient and consistent and therefore no longer is Best Linear Unbiased Estimators (BLUE). Therefore, the Newey-West test was carried out to solve the autocorrelation problem.

Again, after applied Newey-West test to solve autocorrelation problem, Jarque-Bera test (normality test) and Ramsey RESET test (stability test) were needed to test for model specification bias. The error term is not normally distributed and stability test is unstable if the p-value is less than 1% significant level. Since the result from Jarque-Bera test shows that the p-value (0.375228) is greater than 1% significant level, do not reject null hypothesis. Thus, the study concludes that the error term is normally distributed. For the Ramsey RESET test will be another way round, the result shows that the p-value (0.0213) is greater than 1% significant level, do not reject null hypothesis. The study concludes that the model is correctly specified. As a result, the t-test and F-test will be valid, and the model follows normal distribution.



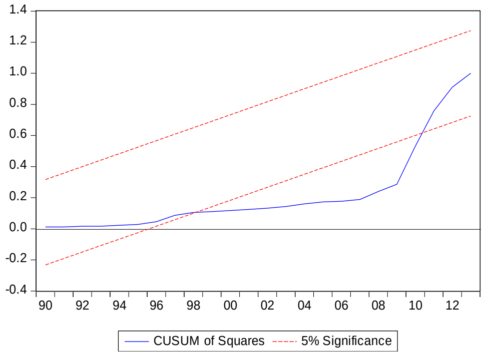


Figure 4.9: CUSUM Test **Figure 4.10: CUSUM Square Test**

Figure 4.9 and Figure 4.10 showed the coefficients are unstable, as the plot of CUSUM and CUSUMSQ falls beyond the range of 5% significant level. The reason behind might be due to the financial crisis happened throughout the period.

4.3 Bound Test for Co-integration

4.3.1 Bound Test for Co-integration in Indonesia

Table 4.11 Result of Bound Test in Indonesia.

Diagnostic Testing	F-Statistic	Upper Critical Value	Lower Critical Value	Conclusion
Bound Test (AIC)	21.87620	4.35	3.23	Co-integration

ARDL bound test is used to investigate the existence of long run relationship between CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services). If F-statistic is greater than the upper critical value, result indicates there is a long-run relationship. Otherwise, if F-statistic is less than the lower critical value, this indicated that there is no long-run relationship. While, if F-statistic is fall between upper and lower critical values, decision is inconclusive. Table 4.11 shows the F-statistic (21.87620) is greater than the upper critical value of 4.35 interpret that it is significant to conclude there is long-run relationship running from GDP by sectors to CO_2 emissions in Indonesia.

4.3.2 Bound Test for Co-integration in Malaysia

Table 4.12 Result of Bound Test in Malaysia.

Diagnostic Testing	F-Statistic	Upper Critical Value	Lower Critical Value	Conclusion
Bound Test (AIC)	5.486530	4.35	3.23	Co-integration

ARDL bound test is used to investigate the existence of long run relationship between CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services). If F-statistic is greater than the upper critical value, result indicates there is a long-run relationship. Otherwise, if F-statistic is less than the lower critical value, this indicated that there is no long-run relationship. While, if F-statistic is fall between upper and lower critical values, the decision is inconclusive. Table 4.12 shows the F-statistic (5.486530) is greater than the upper critical value of 4.35 interpret that it is significant to conclude there is long-run relationship running from GDP by sectors to CO_2 emissions in Malaysia.

4.3.3 Bound Test for Co-integration in Philippines

Table 4.13 Result of Bound Test in Philippines.

Diagnostic Testing	F-Statistic	Upper Critical Value	Lower Critical Value	Conclusion
Bound Test (AIC)	4.053973	4.01	2.86	Co-integration

ARDL bound test is used to investigate the existence of long run relationship between CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services). If F-statistic is greater than the upper critical value, result indicates there is a long-run relationship. Otherwise, if F-statistic is less than the lower critical value, this indicated that there is no long-run relationship. While, if F-statistic is fall between upper and lower critical values, the decision is inconclusive. Table 4.13 shows the F-statistic (4.053973) is greater than the upper critical value of 4.01 interpret that it is significant to conclude there is long-run relationship running from GDP by sectors to CO_2 emissions in Philippines.

4.3.4 Bound Test for Co-integration in Thailand

Table 4.14 Result of Bound Test in Thailand.

Diagnostic Testing	**F-Statistic**	**Upper Critical Value**	**Lower Critical Value**	**Conclusion**
Bound Test (AIC)	12.32825	4.35	3.23	Co-integration

ARDL bound test is used to investigate the existence of long run relationship between CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services). If F-statistic is greater than the upper critical value, result indicates there is a long-run relationship. Otherwise, if F-statistic is less than the lower critical value, this indicated that there is no long-run relationship. While, if F-statistic is fall between upper and lower critical values, the decision is inconclusive. Table 4.14 shows the F-statistic (12.32825) is greater than the upper critical value of 4.01 interpret that it is significant to conclude there is long-run relationship running from GDP by sectors to CO_2 emissions in Thailand.

4.3.5 Bound Test for Co-integration in Vietnam

Table 4.15 Result of Bound Test in Vietnam.

Diagnostic Testing	**F-Statistic**	**Upper Critical Value**	**Lower Critical Value**	**Conclusion**
Bound Test (AIC)	4.992123	4.35	3.23	Co-integration

ARDL bound test is used to investigate the existence of long run relationship between CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services). If F-statistic is greater than the upper critical value, result indicates there is a long-run relationship. Otherwise, if F-statistic is less than the lower critical value, this indicated that there is no long-run relationship. While, if F-statistic is fall between upper and lower critical values, the decision is inconclusive. Table 4.15 shows the F-statistic (4.992123) is greater than the upper critical value of 4.01 interpret that it is significant to conclude there is long-run relationship running from GDP by sectors to CO_2 emissions in Vietnam.

Firstly, the rice production in agriculture sector is also another reason that drives up the amount of CO_2 emissions. According to Khai and Yabe (2011), in 2006, Vietnam provides the world market production of rice of more than 4.6 million tons. Due to its revenue earned solely on rice production, Vietnam has since focused more on rice cultivation. Therefore, it increases in CO_2 emissions in Vietnam. Vietnam has since become the world's second largest exporter of rice. According to Khalil (2009), the usage of nitrogen fertilizers has increases in rice agriculture, methane and nitrous oxide. Three of these have caused approximately 25% of the global warming that has occurred during the last century, thus increasing the CO_2 emissions.

Next, manufacturing sector of Vietnam is one of the main sectors that affect the CO_2 emissions. According to Dinh and Hilmarsson (2014), in 2008, the livestock production has reached over 3.4 million and expected to grow in very quick pacing ever since commercial farms are projected to rise up to 300% in years to come. Since Vietnam's industry has been keep pumping in their cash through livestock production, their factories that produce livestock will use up a lot of electricity which in turns heighten up the CO_2 emissions.

Lastly, services sector of Vietnam also affects the CO_2 emissions. Hue City is one of the smallest but rapidly growing cultural centres of Vietnam, so tourism and attractions plays a crucial role in the GDP of services sector in Vietnam. When the services sector in Vietnam become a point to be focus, the amount of CO_2 emissions that releases will increase. Kusakabe *et al*. (2014) found out that in the services sector of Vietnam, they mainly used goods and services that is associated with tourism, which are infrastructure development and operation, travel, consumption and production of goods and services are energy intensive, this is why the CO_2 emissions in Vietnam for services sector is so high. In 2012, the GDP in tourism sector alone contributed 48% of GDP, revenue from the sector alone worth around US$250 million in same year.

4.4 The Relationship between CO2 emissions and GDP by sector in Agriculture, Manufacturing, and Services.

4.4.1 Does GDP by sectors granger cause CO_2 emissions of Indonesia in short run?

Table 4.16 Estimated short run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Indonesia).

Cointegrating Form (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
D(LNAGR)	-0.720832	0.094800	-7.603716 (0.0169)**
D(LNAGR(-1))	1.594462	0.181577	8.781205 (0.0127)**
D(LNAGR(-2))	-0.422232	0.125428	-3.366327 (0.0781)*
D(LNAGR(-3))	0.445021	0.123909	3.591518 (0.0659)*
D(LNMAN)	-0.121520	0.155331	-0.782329 (0.5159)
D(LNMAN(-1))	-1.347319	0.183470	-7.343541 (0.0180)**
D(LNMAN(-2))	-0.262683	0.146166	-1.797153 (0.2141)
D(LNMAN(-3))	0.813943	0.175692	4.632775 (0.0436)**
D(LNSER)	-0.099085	0.150138	-0.659958 (0.5771)

D(LNSER(-1))	0.387249	0.191142	2.025975 (0.1800)
D(LNSER(-2))	0.353487	0.196758	1.796560 (0.2142)
D(LNSER(-3))	-0.943756	0.188455	-5.007867 (0.0376)**
D(DUMMY)	-0.031359	0.017421	-1.800138 (0.2136)
ECT(-1)	-0.846380	0.152959	-5.533370 (0.0311)**
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

With running the Cointegration and Long Run Form test, Table 4.16 results showed that the agriculture sector is significant in explaining there is short run relationship with CO_2 emissions with p-value of 0.0127 less than 5% significant level. When there is 1% increase in agriculture sector will cause an increase of 1.59% in CO_2 emissions. In additionally, manufacturing and services sectors significant in explain the short run relationship with CO_2 emissions with p-value less than significant level at 5%, which is 0.0436 and 0.0376 respectively. When there is 1% increase in manufacturing sector will cause an increase of 0.81% in CO_2 emissions. Indonesia still in developing stage and tropical deforestation which more energy were needed to advance the country, therefore CO_2 emissions will release and being harmful to environment (Barbier, Burgess and Markandya, 1991).

However, the coefficient of services sector, -0.943756 is in negative sign. When there is 1% increase in services sector, CO_2 emissions will decrease by 0.94%. The reason that services sector of Indonesia has negative relationship with its CO_2 emissions due to they had implement Deep Decarbonization Pathway Project (DDPP) in Indonesia (Siagan, Dewi, Boer, Hendrawan, Yuwono, & Ginting, 2015). Besides that, Siagian, Yuwono, Fujimori, and Masui (2017) found that Indonesia also targeted to reduce greenhouse gas emissions in services sector by 2030, hence, they developed low-carbon energy technologies to decrease the emission gases and this development is aligned with Intended Nationally Determined Contribution (INDC). Besides, CO_2 emission in Indonesia is entering the third stage of EKC hypothesis and therefore services sector can decrease the CO_2 emissions in short run. In order to reduce the amount of emission gases, Indonesia has almost fully countermand fossil fuels subsidiaries and targets to renewable energy (Marqaurdt, 2016).

With additional Error Correction Term (ECT), the final result turn out all the independent variables significant in explain there is short run relationship between CO_2 emissions and GDP by sectors with p-value (0.0311) less than 5% significant level, we reject the null hypothesis.

4.4.2 Does GDP by sectors granger cause CO_2 emissions of Malaysia in short run?

Table 4.17 Estimated short run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Malaysia).

Cointegrating Form (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
D(LNAGR)	-0.347086	0.164612	-2.108510 (0.0612)*
D(LNMAN)	-0.145795	0.257909	-0.565296 (0.5843)
D(LNMAN(-1))	0.807280	0.279573	2.887548 (0.0162)**
D(LNSER)	0.937129	0.311469	3.008737 (0.0131)**
D(LNSER(-1))	-0.651407	0.340820	-1.911296 (0.0850)*
D(LNSER(-2))	-0.358382	0.347122	-1.032438 (0.3262)
D(LNSER(-3))	1.092556	0.283145	3.858644 (0.0032)**
D(DUMMY)	-0.055253	0.032827	-1.683165 (0.1233)
ECT(-1)	-0.151995	0.224495	-0.677052 (0.5137)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

With running the Cointegration and Long Run Form test, Table 4.17 results showed that the agriculture sector is insignificant in explaining there is short run relationship with CO_2 emissions with p-value of 0.0612 greater than 5% significant level, we do not reject null hypothesis. On the other hand, manufacturing and services sectors significant in explain the short run relationship with CO_2 emissions with p-value less than 5% significant level, which is 0.0162 and 0.0032 respectively. When there is 1% increase in manufacturing sector will cause an increase of 0.81% in CO_2

emissions. Also, when there is 1% increase in services sector, will drive level of CO_2 emissions to increase 1.09%.

With additional Error Correction Term (ECT), the final result turn out all the independent variables insignificant in explain there is short run relationship between CO_2 emissions and GDP by sectors with p-value (0.5137) greater than 5% significant level, we do not reject the null hypothesis.

According to Begum *et al*. (2015), from year 1970 to 1980, the consumption of energy increase as economic dominant of Malaysia shifted to industrial sector. Industrialization can generate more income to economy growth but also creates more problems to environment which resulting level of CO_2 emissions roses (Begum *et al*., 2015). Moreover, according to Fong *et al*. (2008), urban planning has a very close relationship with CO_2 emissions and GDP in manufacturing sector. Spatial planning to industrialize a country plays an important role either promote economic growth in right trend or produce CO_2 emissions which is harmful to environment. Energy use involve to give impact to economic growth as process of urban planning to achieve economy goal need to consume a lot of energy, thus issues of CO_2 emissions occurred. According to Fong *et al*. (2008), excessive use of fossil fuel and land use change in Malaysia is the factors that cause the level of CO_2 emissions increases year by year. Besides, big cities are also the factor that creates more CO_2 emissions as nowadays, people are looking for high living standards and plentiful materials (Fong *et al*., 2007, September; October). According to Fong *et al*. (2008), level of CO_2 emissions in Malaysia increasing rapidly due to country become more industrializes. Furthermore, introduction of new technology to have better life such as air-conditioners give significant impact on energy consumption.

According to Fong *et al*. (2008), transportation considered large fraction of GDP in services and is the factor that giving rise to CO_2 emissions. As generation become more and more industrializes, perception of social status that drive people to have own vehicles, that is, fuel vehicles needed to running the transportation resulting release of CO_2 emissions. The level of CO_2 emissions increase because of the demand for transportation rise, and contribute a lot of energy (Fong *et al*., 2008). According to Begum *et al*. (2015), economy in Malaysia currently shifts towards services sector which focus more on energy management system. The energy sources use mainly based on fossil fuels (Indati & Bekhet, 2014). As Malaysia currently in developing progress, more energy needed and will cause level of CO_2 emissions increase. Introduction of public transportation is one of the action taking by Malaysian government to reduce release of CO_2 emissions.

4.4.3 Does GDP by sectors granger cause CO_2 emissions of Philippines in short run?

Table 4.18 Estimated short run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Philippines).

Cointegrating Form (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
D(LNAGR)	0.177778	0.159736	1.112947 (0.2783)
D(LNMAN)	0.956560	0.447207	2.138966 (0.0443)**
D(LNSER)	-1.592421	0.585405	-2.720205 (0.0128)**
D(DUMMY)	0.034832	0.021072	1.652966 (0.1132)
ECT(-1)	-0.193482	0.104880	-1.844790 (0.0792)*
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

With running the Cointegration and Long Run Form test, Table 4.18 results showed that the agriculture sector is insignificant in explaining there is short run relationship with CO_2 emissions with p-value of 0.2783 greater than 5% significant level, we do not reject null hypothesis. On the other hand, manufacturing and services sectors significant in explain the short run relationship with CO_2 emissions with p-value less than 5% significant level, which is 0.0443 and 0.0128 respectively. When there is 1% increase in manufacturing sector will cause an increase of 0.96% in CO_2

emissions. Also, when there is 1% increase in services sector, will cause the level of CO_2 emissions to decrease 1.59%.

With additional Error Correction Term (ECT), the final result turn out all the independent variables insignificant in explain there is short run relationship between CO_2 emissions and GDP by sectors with p-value (0.0792) greater than 5% significant level, we do not reject the null hypothesis.

According to Reyes (2006), It is found that over 65% emissions responsibility of service is from the use of non-service input in match of service demand of water transport and also the uncovered significance of the external factors, such as private and public services. During 1991, the Philippines began to take action towards the climate changes through policies and legal initiatives which explains the increases of service sectors but with lower CO2 emissions (Rincon & Virtucio Jr, 2008, June). The service sector may have shown to be positively unrelated with carbon dioxide emissions at first look but with a much closer look it reveals that service sector is responsible for more carbon dioxide than what it should be (Reyes, 2006). The amount of carbon emissions of the transport is depending on the type of fuel as different fuel gives out a different carbon dioxide emission. Energy consumption for the transportation sectors has a much higher carbon dioxide emission. Moreover, energy sources which are less developed countries as Philippines are inefficient and polluting. Hence high energy consumption results in a much higher carbon dioxide emissions (Palanca-Tan *et al*., 2016).

4.4.4 Does GDP by sectors granger cause CO_2 emissions of Thailand in short run?

Table 4.19 Estimated short run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Thailand).

Cointegrating Form (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**

D(LNAGR)	-0.027490	0.059882	-0.459080 (0.6514)
D(LNAGR(-1))	0.125686	0.071279	1.763286 (0.0939)*
D(LNAGR(-2))	0.145188	0.057808	2.511542 (0.0212)**
D(LNMAN)	0.247856	0.099014	2.503250 (0.0216)**
D(LNSER)	0.528010	0.125573	4.204801 (0.0005)**
D(DUMMY)	-0.021845	0.012052	-1.812556 (0.0857)*
ECT(-1)	-0.749133	0.098860	-7.577727 (0.0000)**
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

With running the Cointegration and Long Run Form test, Table 4.19 results showed that the agriculture sector significant in explain there is short run relationship with CO_2 emissions with p-value of 0.0212 less than 5% significant level. When there is 1% increase in agriculture sector will cause increase of 0.15% in CO_2 emissions. In short run, agriculture sector will cause CO_2 emissions to increase due to Thailand still a developing country, more energy needed to involve in the process to develop the country in short run. On the other hand, manufacturing and services sectors significant in explain the short run relationship with CO_2 emissions with p-value less than 5% significant level, which is 0.0216 and 0.0005 respectively. When there is 1% increase in manufacturing sector will cause increase of 0.25% in CO_2 emissions. Also, when there is 1% increase in Service sector, will drive level of CO_2 emissions increase 0.53%. Moreover, manufacturing sector will also cause the CO_2 emissions increase in short run, this is because there is a large number of factories in Thailand, so this will affecting the environment when those industry emitting high level of CO_2 emissions. According to Barth and Boriboonsomsin (2008, January, pp. 13-15), when the problem of traffic jams increase, CO_2 emissions will increase as well. For instance in Bangkok, Thailand's main city that always facing problem of traffic jams especially during peak hours. While the problem of traffic jams getting more serious, it drives the CO_2 emissions to the higher level.

With add in Error Correction Term (ECT), the final result turn out all the independent variables significant in explain there is short run relationship between CO_2 emissions and GDP by sectors with p-value (0.0000) less than 5% significant level, we reject the null hypothesis.

4.4.5 Does GDP by sectors granger cause CO_2 emissions of Vietnam in short run?

Table 4.20 Estimated short run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Vietnam).

Cointegrating Form (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
D(LNAGR)	-0.096253	0.175451	-0.548606 (0.5893)
D(LNMAN)	-0.274807	0.177661	-1.546806 (0.1376)
D(LNSER)	0.389697	0.359671	1.083484 (0.2915)
D(DUMMY)	-0.009460	0.034459	-0.274530 (0.7865)
ECT(-1)	-0.096139	0.064577	-1.488745 (0.1522)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

With running the Cointegration and Long Run Form test, Table 4.20 results showed that the agriculture sector, manufacturing sector, and services sector are insignificant in explaining that there is a short run relationship with CO_2 emissions. When p-value is greater than 5% significant level, we do not reject null hypothesis. For agriculture sector and manufacturing sector, p-value is 0.5893 and 0.1376 respectively, which is greater than 5% significant level, therefore, we do not reject null hypothesis. Lastly, for services sector, the p-value is 0.2915, which is greater than 5% significant level, and we do not reject null hypothesis.

With add in Error Correction Term (ECT), the final result turn out all the independent variables insignificant in explain there is short run relationship between CO_2 emissions and GDP by sectors with p-value (0.1522) greater than 5% significant level, we do not reject the null hypothesis.

4.4.6 Does GDP by sectors granger cause CO_2 emissions of Indonesia in long run?

Table 4.21 Estimated long run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Indonesia).

Long Run Coefficient (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
LNAGR	-1.409590	0.165721	-8.505801 (0.0135)**
LNMAN	-0.512850	0.141729	-3.618533 (0.0686)
LNSER	2.032478	0.264173	7.693753 (0.0165)**
DUMMY	-0.037051	0.023359	-1.586184 (0.2536)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

Table 4.21 showed the results of long run coefficient of ARDL approach for CO_2 emissions and GDP by sectors (Agriculture, Manufacturing, and Services) in Indonesia. The estimated coefficient for agriculture sector indicate a negative long run impact on CO_2 emissions and the p-value for this sector is 0.0135 which is less than 5 % significant level and significant in explain the long run relationship exist. In addition, the estimated coefficients for services sectors indicate a positive long run impact on CO_2 emissions and the p-value for these two sectors is 0.0165. The p-value is less than 5% significant level and it is significant in explain long run relationship exist. However, manufacturing sector which has negative relationship with CO2 emission is insignificant in explaining the long run relationship exists.

After that, the coefficient of agriculture sector (-1.409590) is in negative sign and showed negative relationship to CO_2 emissions. War and Yusuf (2011) found that Indonesia has effective planning in their land use for forestry. The finding mentioned is same with the finding of Verchot, Petkova, Obidzinski, Atmadja, Yuliani, Dermawan, Murdiyarso, and Amira (2010) which showed that plantation in degraded land can achieve 8% to 12% of emission level reduction. Other than that, Indonesia’s government policy also encourages development of new plantation by industries on degraded land to achieve their 2030 goal.

According to Bowitz, Sasmitawidjaja, and Sugiarto (1996) and Sohag, Mamun, Uddin, and Ahmed (2017), Indonesian more focus on the high-income and middle-income level. This is because they have more purchasing power than the lower-income resident. For example, they may request for foreign goods and services and increase the transportation such as import and export. Other than that, there are other factors that increasing emission level such as development of macroeconomic, electricity, fuels and others.

4.4.7 Does GDP by sectors granger cause CO_2 emissions of Malaysia in long run?

Table 4.22 Estimated long run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Malaysia).

Long Run Coefficient (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
LNAGR	-4.062169	6.515386	-0.623473 (0.5469)
LNMAN	-1.727445	3.785809	-0.456295 (0.6579)
LNSER	4.422904	7.047211	0.627611 (0.5443)
DUMMY	-0.363519	0.661140	-0.549836 (0.5945)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

Based on Table 4.22, result shows long-run relationship does not exists between CO_2 emissions and GDP by sector in Malaysia. The p-value for all independent variables are insignificant in explain there is long run relationship between CO_2 emissions and GDP by sectors as it is greater than 5% significant level with the value of 0.5469, 0.6579, and 0.5443 for agriculture, manufacturing, and services sectors, respectively.

4.4.8 Does GDP by sectors granger cause CO_2 emissions of Philippines in long run?

Table 4.23 Estimated long run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Philippines).

Long Run Coefficient (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
LNAGR	2.551420	1.594007	1.600633 (0.1244)
LNMAN	0.251666	1.912131	0.131616 (0.8965)
LNSER	-1.610260	2.246548	-0.716771 (0.4814)
DUMMY	0.180025	0.144914	1.242289 (0.2278)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

Based on Table 4.23, result shows long-run relationship does not exists between CO_2 emissions and GDP by sector in Philippines. The p-value for all independent variables are insignificant in explain there is long run relationship between CO_2 emissions and GDP by sectors as it is greater than 5% significant level with the value of 0.1244, 0.8965, and 0.4814 for agriculture, manufacturing, and services sectors, respectively.

4.4.9 Does GDP by sectors granger cause CO_2 emissions of Thailand in long run?

Table 4.24 Estimated long run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Thailand).

Long Run Coefficient (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
LNAGR	-0.417523	0.053602	-7.789264 (0.0000)**
LNMAN	0.330857	0.131531	2.515440 (0.0210)**
LNSER	0.704829	0.128766	5.473707 (0.0000)**
DUMMY	-0.029161	0.017075	-1.707790 (0.1040)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

Table 4.24 showed the result of long run coefficient of ARDL approach for CO_2 emissions and GDP by sectors (Agriculture, Manufacture, and Service) in Thailand. The estimated coefficient for agriculture sector indicate a negative long run impact on CO_2 emissions and the p-value for this sector is 0.0000 and p-value is less than the 5% significant level which is significant in explain the long run relationship exist. In addition, the estimated coefficient for manufacturing and services sector indicate a positive long run impact on CO_2 emissions and the p-value for these two sectors is 0.0210 and 0.0000 respectively. Both sectors p-value are less

than 5% significant level which is significant in explain the long run relationship exist.

Since agriculture sector is significant in explain the long run relationship but it was indicated a negative long run impact on CO_2 emissions. According to Nuntavorakarn, Triratsakulchai, Nuntavorakarn, Sopapum, and Wongsakul (2014), promoting of carbon label, enhance low carbon village and preferring renewable energy technologies that use agricultural residuals are the key measures in Agricultural strategy on climate change that cause reduced of CO_2 emissions. Furthermore, according to Mehdi and Slim (2017), United Nations food and agriculture organization (FAO) giving impacts in reducing CO_2 emissions. In the study, they have list out few types of renewable energy that cause the CO_2 emissions decrease in agriculture sector. Solar energy and wind energy were carried out to reduce the level of CO_2 emissions. Solar energy has the function of greenhouse heating, cooling, lighting, product drying, and farm field irrigation. Meanwhile, for wind energy, it can be used to produce electricity, irrigate fields, and grind some of the crops.

Additionally, according to Aimyuak and Wongsapai (2009, April), saying that CO_2 emissions intensity has powered in manufacturing sector than most of the other sector. Therefore, they have analyzed the energy and CO_2 emissions saving in Thailand manufacturing sector by decomposition techniques. From the results, amount of CO_2 emissions has increased that more energy consumption in manufacturing sector while the energy savings in manufacturing sector shows no savings during the period. In addition, according to Todoc *et al*. (2005), CO_2 emission is the main benefactor to greenhouse gases and air pollution in Thailand. They have found out increases of CO_2 emissions even during the period of the financial crisis mainly occur in transport and residential and commercial sectors.

Last but not least, for services sector, results showed that road transportation has the highest CO_2 emissions than other transportation sector such as trucks, trailers, railways, air, and water transportations. The rising of number of vehicle will caused the amount of CO_2 emissions increase sharply. Increasing of public transportation systems especially the Metropolitan Rapid Transit and Bangkok Mass Transit System in Bangkok able to reduce and control the CO_2 emissions (Tanatvanit *et al*., 2003).

4.4.10 Does GDP by sectors granger cause CO_2 emissions of Vietnam in long run?

Table 4.25 Estimated long run coefficient of ARDL approaches (GDP by sectors granger cause CO_2 emissions in Vietnam).

Long Run Coefficient (AIC)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic (p-value)**
LNAGR	-5.612167	3.486528	-1.609672 (0.1231)
LNMAN	-2.858429	3.004012	-0.951537 (0.3527)
LNSER	7.912335	5.679543	1.393129 (0.1789)
DUMMY	-0.098398	0.355008	-0.277171 (0.7845)
Remarks: ***, ** and * denotes significant level at 1%, 5% and 10%.			

Based on the table above, result shows long-run relationship does not exists between CO_2 emissions and GDP by sector in Vietnam. The p-value for all independent variables are insignificant in explain there is long run relationship between CO_2 emissions and GDP by sectors as it is greater than 5% significant level with the value of 0.1231, 0.3527, and 0.1789 for agriculture, manufacturing, and services sectors, respectively.

4.5 Conclusion

Based on the bound test for co-integration, the results show that Indonesia, Malaysia, Philippines, Thailand and Vietnam are co-integration as the F-statistic for each country is greater than the upper critical value. Therefore, it can be conclude that there is long-run relationship running from GDP by sectors to CO2 emissions in every country.

CHAPTER 5: DICUSSION, CONCLUSION AND IMPLICATION

5.0 Summary and Conclusion

The study investigates relationship between CO_2 emissions and GDP by sectors (agriculture, manufacturing, services) in 5 selected ASEAN countries. CO_2 emissions are driven by factors in production. Manufacturing sectors that uses inefficient technologies to produce goods and services are the main reason that CO_2 emissions is high because they has a high-intensive of energy used such as to use large power generation from high calorific gases in iron making (Brown, Gambhir, Florin, & Fennel, 2012).

In Indonesia, result has shown that bi-directional relationship was found between GDP and CO_2 emissions in agriculture sector from literature review (Theoretical) which consistent with the feedback hypothesis. Moreover, the result of bound test has shown that there is no causality relationship between GDP in services sector and CO_2 emissions. Furthermore, the result has shown that causal relationship exists between GDP in manufacturing sector and CO_2 emissions which consistent with the feedback hypothesis. Based on the result from Chapter 4 (Empirical), both sectors are significant in explaining there is short run relationship with CO_2 emissions. In long run, there is a relationship between CO_2 emission with agriculture and services sector except for manufacturing sector.

In Malaysia, the result has shown from literature review (Theoretical) that there is a negative relationship between GDP in agriculture sector and CO_2 emissions which consistent with the conservative hypothesis. There is also short run causality between GDP in agriculture sector and CO_2 emissions, and there will be no long run causality relationship between those two. The result also shows that there is a positive relationship between GDP in manufacturing sector and CO_2

emissions which consistent with the feedback hypothesis. Similarly, this study has also shown that positive relationship exists between GDP in services sector and CO_2 emissions which consistent with the feedback hypothesis. Based on the result from Chapter 4 (Empirical), manufacturing and services sector have short run relationship with CO_2 emissions except for agriculture sector. While in long run, both sectors are insignificant in explaining there is long run relationship with CO_2 emissions so there is no long run relationship between these variables.

In Philippines, the result from literature review (Theoretical) has found out that negative relationship exists between the GDP and CO_2 emissions in agriculture sector and there is a unidirectional causality between CO_2 emissions and GDP in the long term which consistent with growth hypothesis. Moreover, the result has also shown that there is a positive bi-directional causality relationship in manufacturing sector between GDP and CO_2 emissions. Lastly, the result has also shown that there is a unidirectional causality relationship in the services sector between GDP and CO_2 emissions which consistent with the growth hypothesis. In addition, manufacturing and services sector has short run relationship with CO_2 emissions but not in agriculture sector. However, based on the result from Chapter 4 (Empirical), all the sectors have no long run relationship with CO_2 emission in Philippines.

In Thailand, the result from literature review (Theoretical) has shown that the GDP in manufacturing sector and CO_2 emission has a bi-directional causality relationship. Moreover, GDP in services sector and CO_2 emissions has a unidirectional causality relationship which consistent with the growth hypothesis. Lastly, GDP in agriculture sector and CO_2 emissions also has a bi-directional causality relationship too. Based on the result from Chapter 4 (Empirical), all three sectors have long run and short run relationship with CO_2 emissions.

In Vietnam, the result from literature review (Theoretical) has shown that a positive unidirectional causality relationship between GDP and CO_2 emissions in the agriculture sector which consistent with the Growth hypothesis. Moreover, the GDP in manufacturing sector and CO_2 emissions also has a bi-directional causality relationship. The economic growth in services sector and CO_2 emissions also has a unidirectional causality relationship which is consistent to growth hypothesis

. However, based on the result from Chapter 4 (Empirical), there is no significant long run and short run relationship between the variables and CO_2 emissions.

5.1 Policy Implications

Several policies can be implemented to overcome the increasing of carbon dioxide (CO_2) emissions in the selected 5 ASEAN countries which is Malaysia, Vietnam, Thailand, Indonesia, and Philippines. To do so, governments are encouraged to invent a new technology that could convert carbon dioxide emissions to oxygen emissions. Any parties that are able to invent and operate the technology successfully could receive incentives from government as a reward. Not only that the carbon dioxide emissions can be reduced, and also to increase the oxygen emissions which will be a major benefit to everyone.

Moreover, sectors such as agriculture and manufacturing are held responsible for emitting carbon dioxide can provide some education materials and training to the workers in the industry on how to minimize CO_2 emissions. Besides, schools can too educate the students on the negative impact of CO_2 emissions and let them know the consequences of CO_2 emissions and to provide them knowledge on how to reduce the CO_2 emissions. Governments can also take initiatives to increase the awareness of public regarding on how to reduce carbon dioxide emissions in order to maintain an eco-friendly environment, by implementing awareness in the form of street signs in different languages so that foreigners are able to gain as they go. Moreover, government should bring in more eco-friendly transports such as eco green cars, carpool which encourages car sharing, and upgrade the public transports in the service sectors as this is one of the highest co2 emitting sectors in all of the 5 countries. Not only it will decrease the carbon dioxide emission in the area, it will also improve the tourism sector as improvise service will bring in more tourist, as the country will have a better environment for sightseeing.

Lastly, the government should imply a policy to have a restriction on industry that exceeds a certain level of emissions. As different state in different countries has different level of CO_2 emissions, for instance, there will be high level of CO_2 emissions in urban area compared with rural area. In order to focus on both areas, government can put more efforts and attentions on urban area as it does matter the most. To decrease the CO_2 emissions in urban area, government could limit the releases of CO_2 emissions in that particular state. For example, we could suggest the government to implement solar energy for each and every industry and would impose a fined for those who do not follow. This would help in decreasing the CO_2 emissions, and solar energy can be recycled and easy to be obtained by everyone. Each industry can install a device for the solar energy to be stored for night uses.

5.2 Limitations

There are a few limitations found in this study and one of the limitations is that there are different region in different country and each of them has their own rural and urban area. The industries in these areas differ with size depending on the area and the type of industry as they emit will lead to different CO_2 emissions level. Specific studies and data are limited due to the differences. Urban industrialization emits higher CO_2 emissions due to higher demand and their advance of technologies. Advance technologies of the industry consume more energy than the industry in the rural area which will lead to an increase in the CO_2 emissions.

Different states have different energy consumption and are according to the population. As the CO_2 emissions in these states may vary with the usage of energy consumption in advance technology in the population. Some areas will tend to contribute more in the increasing of CO_2 emissions due to population of the certain area. Some states may be more advance than the other and not all states are the same in their demand, sizes and population. Therefore, the energy consumption in the states which have a higher population will tend to increase the emissions of CO_2. The impact of states or location on CO_2 emissions for population in energy consumption is different in the region within the country.

Furthermore, advance technology could be significant but this study does not take this variable into consideration. As the advancement of technology usage varies from countries. For example, Philippines have the highest CO_2 emission due to the lack of advancement of their technology in reducing the CO_2 level, but as for Malaysia it is slightly lower due to the advancement of technology used to control the emission of CO_2 and it is environmental friendly, which is also known as an eco-friendly technology. A poorer country has a disadvantage as they are lacking of eco-friendly technologies to help them to reduce the CO_2 level.

5.3 Recommendations

Different states will have different level of CO_2 emissions but in order to reduce it and make it align with other countries, usage of eco-friendly materials in production is highly recommended in the country that with high level of CO_2 emissions. For example, Nikolaos Vlasopoulos had been invented the Novacem's cement, in which takes in large amounts of carbon dioxide emissions that will make it to be in a harden state, making it carbon negative (Jha, 2008). Besides, future researchers are to be recommended to focus on data either rural or urban state area, as focusing on only one of the specific area of data will provide a more accurate results and will help to minimize any data errors.

Furthermore, due to the high energy consumption of different population in different states, suggestion for the future researchers to investigate only on selected category of population in that area of country as energy consumption in various states such as a more urbanize and developing area emits higher carbon dioxide compared to a more slower growing area. It will be easier for the future researchers to collect the data needed. This would allow them to only focus on urban areas of the states instead of the whole country.

Lastly, due to the lack of technology advancement, it is suggested that the future researchers can go into details and take into consideration about the effect of advance technologies towards the CO_2 level and to identify which advance technologies used to decrease the CO_2 level, try to understand why some areas of the country are not using it and why they has a slower progress of changing to a much more environmental friendly country compared to other countries.

REFERENCES

Ab-Rahim, R., & Xin-Di, T. (2016). The determinants of CO2 emissions in ASEAN+ 3 countries. *Journal of Entrepreneurship and Business*, *4*(1), 26-37.

Afroz, R., Hassan, M. N., & Ibrahim, N. A. (2003). Review of air pollution and health impacts in Malaysia. *Environmental research*, *92*(2), 71-77.

Aimyuak, Y., & Wongsapai, W. (2009, April). The Analysis of Energy Saving and Carbon Dioxide Emissions in Thai Manufacturing Sector by Decomposition Technique. *Proceedings of the 5th Conference on Energy Network of Thailand (E-NETT), 29*.

Alam, J. (2015). Impact of Agriculture, Industry and Service Sector's Value Added in the GDP on CO2 Emissions of Selected South Asian Countries. *World Review of Business Research*, *5*(2), 39–59.

Alberola, E., Chevallier, J., & Cheze, B. (2008). The EU emissions trading scheme: The effects of industrial production and CO2 emissions on carbon prices. *Economie internationale*, (4), 93-125.

Alshehry, A. S., & Belloumi, M. (2015). Energy consumption, carbon dioxide emissions and economic growth: The case of Saudi Arabia. *Renewable and Sustainable Energy Reviews*, *41*, 237-247.

Ang, J. B. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling*, *30*(2), 271-278.

Arvin, M. B., Pradhan, R. P., & Norman, N. R. (2015). Transportation intensity, urbanization, economic growth, and CO 2 emissions in the G-20 countries. *Utilities Policy*, *35*, 50-66.

Asumadu-Sarkodie, S., & Owusu, P. A. (2016). The relationship between carbon dioxide and agriculture in Ghana: A comparison of VECM and ARDL model. *Environmental Science and Pollution Research*, *23*(11), 10968-10982. doi: 10.1007/s11356-016-6252-x

Avitabile, V., Schultz, M., Herold, N., De Bruin, S., Pratihast, A. K., Manh, C. P., Quang, H. V., & Herold, M. (2016). Carbon emissions from land cover change in Central Vietnam. *Carbon Management*, *7*(5-6), 333-346.

Bak, K. M., Chong, P. X., Ho, L. P., Phoon, K. Y., & Teng, S. Y. (2016). *Relationship between Renewable Energy, Economic Growth and Carbon Dioxide (Co2) In Malaysia* (Doctoral dissertation, UTAR).

Barbier, E. B., Burgess, J. C., & Markandya, A. (1991). The economics of tropical deforestation. *Ambio*, 55-58.

Barth, M., & Boriboonsomsin, K. (2008, January). Real-World CO2 Impacts of Traffic Congestion. TRB 2008 Annual Meeting CD-ROM. In *Proceedings of the 87th Annual Meeting of the Transportation Research Board, Washington, DC, USA* (pp. 13-15).

Baum, C. F., Schaffer, M. E., & Stillman, S. (2007). Enhanced routines for instrumental variables/GMM estimation and testing. *Stata Journal*, *7*(4), 465-506.

Begum, R. A., Sohag, K., Abdullah, S. M. S., & Jaafar, M. (2015). CO 2 emissions, energy consumption, economic and population growth in Malaysia. *Renewable and Sustainable Energy Reviews, 41*, 594-601.

Behera, J. (2015). Examined The Energy-Led Growth Hypothesis In India: Evidence From Time Series Analysis. *Energy Economics Letters, 2*(4), 46-65.

Bekhet, H. A., & Yasmin, T. (2013). Disclosing the relationship among CO2 emissions, energy consumption, economic growth and bilateral trade between Singapore and Malaysia: an econometric analysis. *World Academy of Science, Engineering and Technology, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *7*(9), 2529-2534.

Belke, A., Dreger, C., & de Haan, F. (2010). *Energy Consumption and Economic Growth–New Insights into the Cointegration Relationship* (No. 0190). Rheinisch-Westfalisches Institut fur Wirtschaftsforschung, Ruhr-Universitat Bochum, Technische Universitat Dortmund, Universitat Duisburg-Essen.

Ben Jebli, M., Ben Youssef, S., & Apergis, N. (2014). The dynamic linkage between CO2 emissions, economic growth, renewable energy consumption, number of tourist arrivals and trade.

Bera, A. K., & Higgins, M. L. (1993). ARCH models: Properties, estimation and testing. *Journal of Economic Surveys*, *7*(4), 305-366.

Biswas, A. (2014). Bright Future for Indonesia’s Agriculture Sector. *Global Indonesian Voices*. Retrieved 24 September, 2014 from http://www.globalindonesianvoices.com/15797/bright-future-for-indonesias-agriculture-sector/

Bouznit, M., & Pablo-Romero, M. P., (2016). CO2 emission and economic growth in Algeria. *Energy Policy*, *96*, 93-104.

Bowitz, E., S. Sasmitawidjaja, V. & Sugiarto, G. (1996). The Indonesian Economy and Emissions of CO2: An Analysis Based on the EnvironmentalMacroeconomic-Model MEMLI, 1990-2020. *Statistics Norway.*

Brown, T., Gambhir, A., Florin, N., & Fennell, P. (2012). Reducing CO2 emissions from heavy industry: a review of technologies and considerations for policy makers. *Grantham Institute Briefing Paper*, *7*.

Carlson, K. M., Curran, L. M., Ratnasari, D., Pittman, A. M., Soares-Filho, B. S., Asner, G. P., Trigg, S. N., Gaveau, D. A., Lawrence, D. & Rodrigues, H. O. (2012). Committed carbon emissions, deforestation, and community land conversion from oil palm plantation expansion in West Kalimantan, Indonesia. *Proceedings of the National Academy of Sciences*, *109*(19), 7559-7564.

Carlsson-Kanyama, A., & Gonzalez, A. D. (2007). *Non-CO2 greenhouse gas emissions associated with food production: methane (CH4) and nitrous oxide (N20)*. Division of Industrial Ecology, KTH.

Cavaliere, G., Phillips, P. C., Smeekes, S., & Taylor, A. R. (2015). Lag length selection for unit root tests in the presence of nonstationary volatility. *Econometric Reviews*, *34*(4), 512-536.

Chaabouni, S., Zghidi, N., & Mbarek, M. B. (2016). On the causal dynamics between CO 2 emissions, health expenditures and economic growth. *Sustainable Cities and Society*, *22*, 184-191.

Chaudhry, P., & Ruysschaert, G. (2007). Climate change and human development in Vietnam. *Human development report*, *2008*.

Chen, Y. T., & Kuan, C. M. (2003). *A generalized Jarque-Bera test of conditional normality* (No. 03-A003). Institute of Economics, Academia Sinica, Taipei, Taiwan.

Cheng, B. S. (1999). Causality between energy consumption and economic growth in India: An application of co-integration ad error-correction modeling. *Indian Economic Review, 34*(1), 39-49.

Criqui, P., Peytral, P. O., & Simon, J. C. (2012). Fostering low carbon growth initiatives in Thailand.

D'Agostino, R. B., & Stephens, M. A. (1986). Goodness-of-fit Techniques, New York: Marcel Dekker.

Davis, S. J., & Caldeira, K. (2010). Consumption-based accounting of CO2 emissions. *Proceedings of the National Academy of Sciences*, *107*(12), 5687-5692.

Deviren, S. A., & Deviren, B. (2016). The relationship between carbon dioxide emission and economic growth: Hierarchical structure methods. *Physica A: Statistical Mechanics and its Applications*, *451*, 429-439.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological economics*, *49*(4), 431-455.

Dinh, T. Q., & Hilmarsson, H. Þ. (2014). FOOD PROCESSING IN VIETNAM: WHERE IS THE POTENTIAL FOR HIGH VALUE EXPORT?. *Regional Formation and Development Studies*, *12*(1), 60-73.

Dodman, D. (2009). Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories. *Environment and Urbanization*, *21*(1), 185-201.

Du, L., Wei, C., & Cai, S. (2012). Economic development and carbon dioxide emissions in China: Provincial panel data analysis. *China Economic Review*, *23*(2), 371-384.

Duncan, B. N., Bey, I., Chin, M., Mickley, L. J., Fairlie, T. D., Martin, R. V., & Matsueda, H. (2003). Indonesian wildfires of 1997: Impact on tropospheric chemistry. *Journal of Geophysical Research: Atmospheres*, *108*(D15).

Ejuvbekpokpo, S. A. (2014). Impact of carbon emissions on economic growth in Nigeria. *Asian Journal of Basic and Applied Sciences*, *l*, 16-24.

Engle, R. (2001). GARCH 101: The use of ARCH/GARCH models in applied econometrics. *The Journal of Economic Perspectives*, *15*(4), 157-168.

Everitt, B. S., & Skrondal, A. (1998). THE CAMBRIDGE DICTIONARY OF STATISTICS (4th ed). New York: Cambridge University Press.

Evrendilek, F., & Ertekin, C. (2002). Agricultural sustainability in Turkey: integrating food, environmental and energy securities. *Land Degradation & Development*, *13*(1), 61-67.

Farhani, S., Shahbaz, M., & Ozturk, I. (2014). *Coal consumption, industrial production and CO2 emissions in China and India*. Working Papers 2014-225, Department of Research, Ipag Business School.

Fong, W. K., Matsumoto, H., Ho, C. S., & Lun, Y. F. (2008). Energy consumption and carbon dioxide emission considerations in the urban planning process in Malaysia. *Planning Malaysia Journal*, *6*(1).

Fong, W. K., Matsumoto, H., Lun, Y. F., & Kimura, R. (2007, October). System dynamic model for the prediction of urban energy consumption trends. In *Proceeding 1 of the 6th international conference on indoor air quality, ventilation & energy conservation in buildings (IAQVEC 2007)*, pp. 762-769.

Fong, W. K., Matsumoto, H., Lun, Y. F., & Kimura, R. (2007, September). System dynamic model as decision making tool in urban planning from the perspective of urban energy consumption. In *Seminar Proceedings of the 3rd Seminar of JSPS-VCC (Group VII)*, pp. 10-11.

Geist, H. J. (1999). Soil mining and societal responses. *Lohnert Band Geist H eds. Coping with Changing Environments. Ashgate Publications*, *57*, 75-80.

Gota, S. (2014). Issues with Philippines Road Transport Energy Consumption. *Open Journal of Energy Efficiency*, 3, 14-24.

Greene, W. H. (1997). *Econometric Analysis* (3rd ed.). Macmillan Publishing Company.

Gujarati, D. N., & Dawn, P. C. (2009). *Basic Econometrics*. New York: McGraw-Hill.

Hamrita, M. E., & Mekdam, M. (2016). Energy consumption, CO2 emissions and economic growth nexus: Evidence from panel Granger causality test.

Hansen, S. (2007). Feasibility study of performing an life cycle assessment on crude palm oil production in Malaysia (9 pp). *The International Journal of Life Cycle Assessment*, *12*(1), 50-58.

Hao, Y., Chen, H., Wei, Y. M., & Li, Y. M. (2016). The influence of climate change on CO 2 (carbon dioxide) emissions: an empirical estimation based on Chinese provincial panel data. *Journal of Cleaner Production*, *131*, 667-677.

Heidari, H., Katircioğlu, S. T., & Saeidpour, L. (2015). Economic growth, CO 2 emissions, and energy consumption in the five ASEAN countries. *International Journal of Electrical Power & Energy Systems*, *64*, 785-791.

Hill, R. J., & Magnani, E. (2002). An exploration of the conceptual and empirical basis of the environmental Kuznets curve. *Australian Economic Papers*, *41*(2), 239-254.

Hong, Y., & Shehadeh, R. D. (1999). A new test for ARCH effects and its finite-sample performance. *Journal of Business & Economic Statistics*, *17*(1), 91-108.

Indati, M. S., & Bekhet, H. A. (2014). Highlighting of the factors and policies affecting CO2 emissions level in Malaysian transportation sector. *International Journal of Environmental, Earth Science and Engineering*, *8*(1), 10-18.

Jha, A. (2008). Revealed: The cement that eats carbon dioxide. *Green Technology Correspondent*, *1*, 16-24.

Kalimeris, P., Richardson, C., & Bithas, K. (2014). A meta-analysis investigation of the direction of the energy-GDP causal relationship: implications for the growth-degrowth dialogue. *Journal of Cleaner Production*, *67*, 1-13.

Khai, H. V., & Yabe, M. (2011). Technical efficiency analysis of rice production in Vietnam. *Journal of ISSAAS*, *17*(1), 135-146.

Khalil, M. A. K. (2009). *Emissions Of Greenhouse Gases From Rice Agriculture* (No. DOE/ER/63913-1). Portland State University, Portland, Oregon.

Kimball, B. A., Kobayashi, K., & Bindi, M. (2002). Responses of agricultural crops to free-air CO_2 enrichment. *Advances in Agronomy*, *77*, 293-368.

Kisner, C. (2008). Climate change in Thailand: Impacts and adaptation strategies. Retrieved April 5, 2017, from http://climate.org/archive/topics/international-action/thailand.htm

Kongrukgreatiyos, K., & Chung, D. Y. W. (2016). Thailand to Reduce Harmful Emissions from Deforestation with World Bank Support. *The World Bank*. Retrieved 14 September, 2016 from http://www.worldbank.org/en/news/press-release/2016/09/14/thailand-to-reduce-harmful-emissions-from-deforestation

Krackeler, T., Schipper, L., & Sezgen, O. (1998). Carbon dioxide emissions in OECD service sectors: the critical role of electricity use. *Energy Policy*, *26*(15), 1137-1152.

Kulionis, V. (2013). The relationship between renewable energy consumption, CO2 emissions and economic growth in Denmark. *Master programme in Economic Growth, Innovation and Spatial Dynamics.*

Kusakabe, K., Shrestha, P., S. Kumar, Nguyen, K. L. (2014, May). Advancing green growth in the tourism sector: The case of Hue, Vietnam. *Climate* & Development Knowledge Network. Retrieved April 5, 2017, from https://cdkn.org/wp-content/uploads/2014/05/Hue-Inside-Story_WEB.pdf

Lean, H. H., & Smith, R. (2009). *CO2 EMISSIONS, ELECTRICITY CONSUMPTION AND OUTPUT IN ASEAN* (No. 13-09). Monash University, Department of Economics.

Lean, H. H., & Smith, R. (2010). CO_2 emissions, electricity consumption and output in ASEAN. *Applied Energy*, *87*(6), 1858-1864.

Lee, J. W., & Brahmasrene, T. (2013). Investigating the influence of tourism on economic growth and carbon emissions: Evidence from panel analysis of the European Union. *Tourism Management*, *38*, 69-76.

Lim, K. M., Lim, S. Y., & Yoo, S. H. (2014). Oil consumption, CO2 emission, and economic growth: Evidence from the philippines. *Sustainability*, *6*(2), 967-979.

Magazzino, C. (2014). A Panel VAR Approach of the Relationship among Economic Growth, CO2 Emissions, and Energy Use in the ASEAN-6 Countries. *International Journal of Energy Economics and Policy*, *4*(4), 546-553.

Magazzino, C. (2016). The relationship between real GDP, CO2 emissions, and energy use in the GCC countries: A time series approach. *Cogent Economics & Finance*, *4*(1), 1152729.

Managi, S. (2006). Are there increasing returns to pollution abatement? Empirical analytics of the Environmental Kuznets Curve in pesticides. *Ecological Economics*, *58*(3), 617-636.

Marquardt, J. (2016). Indonesia: A Long Way to Low-Carbon Development. *Sustainable Energy in the G20,* 64-69.

Mazzanti, M., Montini, A., & Zoboli, R. (2007). *Economic Dynamics, Emission Trends and the EKC Hypothesis New Evidence Using NAMEA and Provincial Panel Data for Italy* (No. 24.2007). doi: org/10.2139/ssrn.970270.

Mehdi, B. J., & Slim, B. Y. (2017). The role of renewable energy and agriculture in reducing CO 2 emissions: Evidence for North Africa countries. *Ecological Indicators*, *74*, 295-301.

Mendelsohn, R., Dinar, A., & Williams, L. (2006). The distributional impact of climate change on rich and poor countries. *Environment and Development Economics*, *11*(02), 159-178.

Mendelsohn, R., Nordhaus, W. D., & Shaw, D. (1994). The impact of global warming on agriculture: a Ricardian analysis. *The American economic review*, 753-771.

Menegaki, A. N. (2014). On energy consumption and GDP studies; A meta-analysis of the last two decades. *Renewable and Sustainable Energy Reviews*, *29*, 31-36.

Moffatt, M. (2017). An Introduction to Akaike's Information Criterion (AIC). *ThoughtCo*. Retrieved March 29, 2017, from https://www.thoughtco.com/introduction-to-akaikes-information-criterion-1145956

Mohsen, M., & ali Razaei, A. (2013). Panel Estimation of the Relationship Between Trade Liberalization, Economic Growth and CO2 Emissions in BRICS Countries. *Hyperion Economic Journal, 1*(4), 3-27.

Mugableh, M. I. (2013). Analysing the CO2 emissions function in Malaysia: Autoregressive distributed lag approach. *Procedia Economics and Finance*, *5*, 571-580.

Mukhopadhyay, K., & Thomassin, P. J. (2010). Economic and Environmental Impact of Free Trade in East and South East Asia. *Springer Dordrecht Heidelberg London New York.*

Niu, S., Ding, Y., Niu, Y., Li, Y., & Luo, G. (2011). Economic growth, energy conservation and emissions reduction: A comparative analysis based on panel data for 8 Asian-Pacific countries. *Energy Policy, 39*(4), 2121-2131.

Nuntavorakarn, S., Triratsakulchai, N., Nuntavorakarn, B., Sopapum, N., & Wongsakul, P. (2014). The survey and assessment of the appropriate share of climate change mitigation actions in developing countries: The case of Thailand.

Omri, A. (2015). CO 2 emissions, energy consumption and economic growth nexus in MENA countries: evidence from simultaneous equations models. *Energy economics*, *40*, 657-664.

Osu, B. O., Okonkwo, C. U., & Ujumadu, R. N. (2016). The Relationship between GDP and Co2 Emission in Nigeria Using the Least Square Polynomials. *Academic Journal of Applied Mathematical Sciences*, *2*(6), 51-55.

Page, S. E., Siegert, F., Rieley, J. O., Boehm, H. D. V., Jaya, A., & Limin, S. (2002). The amount of carbon released from peat and forest fires in Indonesia during 1997. *Nature*, *420*(6911), 61-65.

Palanca-Tan, R., Dy, T. A., & Tan, A. (2016). Relating Carbon Dioxide Emissions with Macroeconomic Variables in the Philippine Setting. *Low Carbon Economy*, *7*(01), 12.

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

Phan, T. T. H. (2007). International visitors to Vietnam in December and 12 months of year 2006. *Vietnam National Administration of Tourism*. Retrieved 5 January, 2007 from http://vietnamtourism.gov.vn/english/index.php/items/6718

Ramesh, M., & Howlett, M. (2006). Deregulation and its discontents: Rewriting the rules in Asia. *Edward Elgar Publishing*.

Razali, N. M., & Yap, B. W. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *Journal of Statistical Modeling and Analytics*, *2*(1), 21-33.

Reilly, J., & Hohmann, N. (1993). Climate change and agriculture: the role of international trade. *The American Economic Review*, *83*(2), 306-312.

Reyes, R. C. (2006). Demand decomposition and subsystems input-output analysis of the CO2 emissions of the service sector in the Philippines. Retrieved from https://www.iioa.org/conferences/22nd/papers/files/1891_20140310110_SubsystemsIO_2006.pdf

Rincon, M. F. G., & Virtucio Jr, F. K. (2008, June). Climate change in the Philippines: A contribution to the country environmental analysis. In *Proceedings of the Country Environmental Analysis Consultative Workshops, Manila, Philippines*.

Saatci, M., & Dumrul, Y. (2013). The relationship between energy consumption and economic growth: Evidence from a structural break analysis for

Turkey. *International Journal of Energy Economics and Policy*, *3*(1), 20-29.

Saboori, B., & Soleymani, A. (2011). Environmental Kuznets curve in Indonesia, the role of energy consumption and foreign trade.

Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic growth and CO 2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. *Energy Policy*, *51*, 184-191. doi: 10.1016/j.enpol.2012.08.065

Saidi, K., & Hammami, S. (2015a). The impact of CO 2 emissions and economic growth on energy consumption in 58 countries. *Energy Reports, 1*, 62-70.

Saidi, K., & Hammami, S. (2015b). The impact of energy consumption and CO 2 emissions on economic growth: fresh evidence from dynamic simultaneous-equations models. *Sustainable Cities and Society*, *14*, 178-186.

Sandhu, S., Sharma, D., & Vaiyavuth, R. (n.d.). Energy Related Greenhouse-Gas Emissions In The ASEAN: A Decomposition Analysis. In *IAEE Asian Conference Proceedings* (Vol. 3, pp. 1-12).

Sangpenchan, R. (2009). *Climate change impacts on cassava production in Northeastern Thailand.* (Doctoral dissertation, The Pennsylvania State University).

Sari, R., & Soytas, U. (2009). Are global warming and economic growth compatible? Evidence from five OPEC countries? *Applied Energy*, *86*(10), 1887-1893.

Say, N. P., & Yucel, M. (2006). Energy consumption and CO 2 emissions in Turkey: empirical analysis and future projection based on an economic growth. *Energy Policy*, *34*(18), 3870-3876.

Siagan, U. W. R., Dewi, R. G., Boer, R., Hendrawan, I., Yuwono, B. B., & Ginting, G. E. (2015). *Pathways to deep decarbonization in Indonesia*, SDSN - IDDRI.

Siagian, U. W., Yuwono, B. B., Fujimori, S., & Masui, T. (2017). Low-Carbon Energy Development in Indonesia in Alignment with Intended Nationally Determined Contribution (INDC) by 2030. *Energies*, *10*(1), 52.

Sohag, K., Al Mamun, M., Uddin, G. S., & Ahmed, A. M. (2017). Sectoral output, energy use, and CO2 emission in middle-income countries. *Environmental Science and Pollution Research*, *24*(10), 9754-9764.

Solarin, S. A. (2014). Tourist arrivals and macroeconomic determinants of CO2 emissions in Malaysia. *Anatolia*, *25*(2), 228-241.

Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World development*, *32*(8), 1419-1439.

Suanmali, S., & Limmeechokchai, B. (2013). The assessment of biofuel utilization policy on the total output and CO_2 emissions in Thailand. *Journal of Engineering, Project, and Production Management*, *3*(2), 57-64.

Tanatvanit, S., Limmeechokchai, B., & Chungpaibulpatana, S. (2003). Sustainable energy development strategies: Implications of energy demand management and renewable energy in Thailand. *Renewable and Sustainable Energy Reviews, 7*, 367-395.

Tiwari, A. K. (2011). Energy consumption, CO2 emissions and economic growth: Evidence from India. *Journal of International Business and Economy*, *12*(1), 85-122.

Todoc, J. L., Todoc, M. J., & Lefevre, T. (2005). Indicators for sustainable energy development in Thailand. *Natural Resources Forum*, *29*(4), 343-359.

Ubaidillah, N. Z., Decker, L., Ab. Rahim, R., & Ismail, F. (2013). The Nexus Between Trade Openness And Co2 Emissions In Selected Bimp-Eaga Countries. *BIMP-EAGA Journal for Sustainable Tourism Development, 2*(2), 22-39.

UI-Islam, T. (2011). Normality testing- A new direction. *International Journal of Business and Social Science, 2*(3), 115-118.

Van Minh, H., Giang, K. B., Bich, N. N., & Huong, N. T. (2009). Tobacco farming in rural Vietnam: questionable economic gain but evident health risks. *BMC Public Health, 9*(1), 24.

Verchot, L. V., Petkova, E., Obidzinski, K., Atmadja, S., Yuliani, L., Dermawan, A., Murdiyarso, D. & Amira, S. (2010). Reducing forestry emissions in Indonesia.

Wang, S., Zhou, C., Li, G., & Feng, K. (2016). CO 2, economic growth, and energy consumption in China's provinces: Investigating the spatiotemporal and econometric characteristics of China's CO 2 emissions. *Ecological Indicators*, *69*, 184-195.

Wang, W., Van Gelder, P. H. A. J. M., Vrijling, J. K., & Ma, J. (2005). Testing and modelling autoregressive conditional heteroskedasticity of streamflow processes. *Nonlinear Processes in Geophysics*, *12*(1), 55-66.

Wooldridge, J. M. (2002). Econometric analysis of cross section and panel data. *The MIT Press Cambridge* (pp. 124-125). London: Massachusetts.

World Bank. (2009). *Project Appraisal Document On A Proposed Credit In the Amount of SDR 42.1 Million (US$ 65.26 Million Equivalent) to the Socialist Republic Of Vietnam For A Livestock Competitiveness and Food Safety Project. East Asia and Pacific Region: The World Bank*. Retrieved August 28, 2013, from http://documents.worldbank.org/curated/en/276741468328186419/%20pdf/501610PAD0P0901ly10IDA1R20091024411.pdf

WorldBank. (2010a). Agriculture, value added (% of GDP). Retrieved from http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

WorldBank. (2010b). CO2 emissions (metric tons per capita). Retrieved from http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

WorldBank. (2010c). GDP growth (annual %). Retrieved from http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

WorldBank. (2010d). Services, etc., value added (% of GDP). Retrieved from http://data.worldbank.org/indicator/NV.SRV.TETC.ZS

Yang, H. Y. (2000). A note on the causal relationship between energy and GDP in Taiwan. *Energy economics*, *22*(3), 309-317.

York, R. (2012). Asymmetric effects of economic growth and decline on CO2 emissions. *Nature Climate Change*, *2*(11), 762-764.

Zaman, K., Khan, M. M., Ahmad, M., & Rustam, R. (2012). The relationship between agricultural technology and energy demand in Pakistan. *Energy Policy*, *44*, 268-279.

APPENDIXES

Appendix 1: Indonesia

Unit Root Test : Augmented Dickey-Fuller

Level Form: Trend and Intercept

Carbon dioxide

Null Hypothesis: LNCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.068381	0.7149
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Agriculture

Null Hypothesis: LNAGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.186005	0.9287
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

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

GDP in Manufacturing

Null Hypothesis: LNMAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.113622	0.0379

Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

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

GDP in Services

Null Hypothesis: LNSER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.246679	0.9202
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

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

First Different: Intercept

Carbon dioxide

Null Hypothesis: D(LNCO2) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.300824	0.0002
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

GDP in Agriculture

Null Hypothesis: D(LNAGR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.846593	0.0075
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

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

GDP in Manufacturing

Null Hypothesis: D(LNMAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.131646	0.0370
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

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

GDP in Services

Null Hypothesis: D(LNSER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.818059	0.0001
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

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

ARCH Test

Heteroskedasticity Test: ARCH

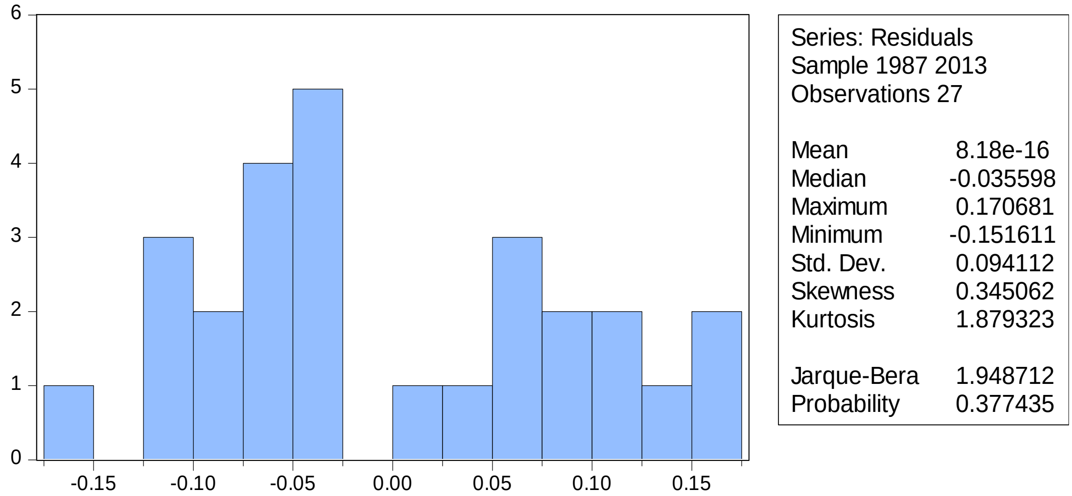
F-statistic	2.967436	Prob. F(1,24)	0.0978
Obs*R-squared	2.860982	Prob. Chi-Square(1)	0.0908

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.393784	Prob. F(2,20)	0.6796
Obs*R-squared	1.022934	Prob. Chi-Square(2)	0.5996

JarqueBera Normality Test



Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNAGR LNMAN LNSER DUMMY C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.715994	21	0.1009
F-statistic	2.944637	(1, 21)	0.1009
Likelihood ratio	3.542992	1	0.0598

Bound Test for Co-integration

ARDL Bounds Test
Date: 06/19/17 Time: 18:10
Sample: 1991 2013
Included observations: 23
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	21.87620	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35

2.5%	3.69	4.89
1%	4.29	5.61

ARDL Short Run and Long Run Estimation

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(4, 4, 4, 4)
Date: 06/19/17 Time: 18:10
Sample: 1983 2013
Included observations: 23

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCO2(-1))	0.842546	0.166133	5.071529	0.0367
D(LNCO2(-2))	-0.096998	0.156860	-0.618372	0.5994
D(LNCO2(-3))	-0.651990	0.137488	-4.742154	0.0417
D(LNAGR)	-0.720832	0.094800	-7.603716	0.0169
D(LNAGR(-1))	1.594462	0.181577	8.781205	0.0127
D(LNAGR(-2))	-0.422232	0.125428	-3.366327	0.0781
D(LNAGR(-3))	0.445021	0.123909	3.591518	0.0695
D(LNMAN)	-0.121520	0.155331	-0.782329	0.5159
D(LNMAN(-1))	-1.347319	0.183470	-7.343541	0.0180
D(LNMAN(-2))	-0.262683	0.146166	-1.797153	0.2141
D(LNMAN(-3))	0.813943	0.175692	4.632775	0.0436
D(LNSER)	-0.099085	0.150138	-0.659958	0.5771
D(LNSER(-1))	0.387249	0.191142	2.025975	0.1800
D(LNSER(-2))	0.353487	0.196758	1.796560	0.2142
D(LNSER(-3))	-0.943756	0.188455	-5.007867	0.0376
D(DUMMY)	-0.031359	0.017421	-1.800138	0.2136
CointEq(-1)	-0.846380	0.152959	-5.533370	0.0311

Cointeq = LNCO2 - (-1.4096*LNAGR -0.5128*LNMAN + 2.0325*LNSER -0.0371*DUMMY + 7.4178)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-1.409590	0.165721	-8.505801	0.0135

LNMAN	-0.512850	0.141729	-3.618533	0.0686
LNSER	2.032478	0.264173	7.693753	0.0165
DUMMY	-0.037051	0.023359	-1.586184	0.2536
C	7.417817	0.939314	7.897058	0.0157

Appendix 2: Malaysia

Unit Root Test : Augmented Dickey-Fuller

Level Form: Trend and Intercept

Carbon dioxide

Null Hypothesis: LNCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.972860	0.7499
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Agriculture

Null Hypothesis: LNAGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.029321	0.9484
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Manufacturing

Null Hypothesis: LNMAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.542893	0.4986
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Services

Null Hypothesis: LNSER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.121029	0.9621
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

First Different: Intercept

Carbon dioxide

Null Hypothesis: D(LNCO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.360786	0.0001
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	

	10% level	-2.622989

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

GDP in Agriculture

Null Hypothesis: D(LNAGR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.504270	0.0001
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

GDP in Manufacturing

Null Hypothesis: D(LNMAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.212921	0.0027
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Services

Null Hypothesis: D(LNSER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.485359	0.0013
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	2.787179	Prob. F(1,28)	0.1062
Obs*R-squared	2.715916	Prob. Chi-Square(1)	0.0994

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	6.463108	Prob. F(2,24)	0.0057
Obs*R-squared	10.85171	Prob. Chi-Square(2)	0.0044

Newey-West Test

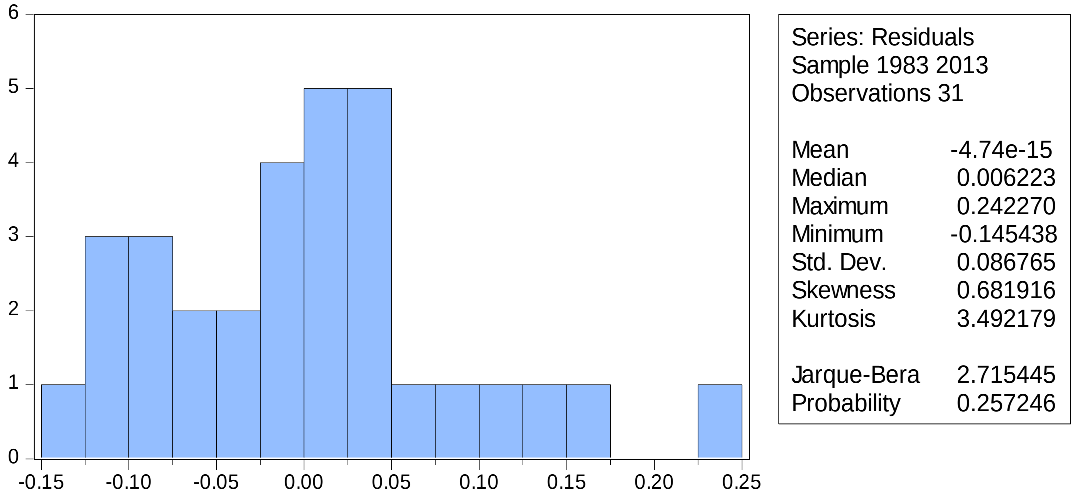
Dependent Variable: LNCO2
Method: Least Squares
Date: 06/19/17 Time: 18:16
Sample: 1983 2013
Included observations: 31
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.139165	0.144420	-0.963613	0.3441
LNMAN	0.508590	0.089433	5.686836	0.0000
LNSER	0.235077	0.149395	1.573523	0.1277
DUMMY	-0.026163	0.027466	-0.952577	0.3496
C	-3.754444	1.080193	-3.475715	0.0018

R-squared	0.980901	Mean dependent var	11.54999
Adjusted R-squared	0.977963	S.D. dependent var	0.627827
S.E. of regression	0.093200	Akaike info criterion	-1.761439
Sum squared resid	0.225844	Schwarz criterion	-1.530151

Log likelihood	32.30231	Hannan-Quinn criter.	-1.686045
F-statistic	333.8344	Durbin-Watson stat	0.856289
Prob(F-statistic)	0.000000	Wald F-statistic	772.3483
Prob(Wald F-statistic)	0.000000		

JarqueBera Normality Test



Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNAGR LNMAN LNSER DUMMY C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	3.937218	25	0.0006
F-statistic	15.50169	(1, 25)	0.0006
Likelihood ratio	14.95650	1	0.0001

Bound Test for Co-integration

ARDL Bounds Test
Date: 06/19/17 Time: 18:11
Sample: 1987 2013
Included observations: 27
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.486530	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Short Run and Long Run Estimation

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(3, 1, 4, 4)
Date: 06/19/17 Time: 18:12
Sample: 1983 2013
Included observations: 27

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCO2(-1))	-0.634586	0.272200	-2.331323	0.0420
D(LNCO2(-2))	-0.359259	0.257630	-1.394473	0.1934
D(LNAGR)	-0.347086	0.164612	-2.108510	0.0612
D(LNMAN)	-0.145795	0.257909	-0.565296	0.5843
D(LNMAN(-1))	0.807280	0.279573	2.887548	0.0162
D(LNMAN(-2))	0.254787	0.277449	0.918318	0.3801
D(LNMAN(-3))	-0.581085	0.227091	-2.558821	0.0284
D(LNSER)	0.937129	0.311469	3.008737	0.0131
D(LNSER(-1))	-0.651407	0.340820	-1.911296	0.0850
D(LNSER(-2))	-0.358382	0.347122	-1.032438	0.3262
D(LNSER(-3))	1.092556	0.283145	3.858644	0.0032
D(DUMMY)	-0.055253	0.032827	-1.683165	0.1233
CointEq(-1)	-0.151995	0.224495	-0.677052	0.5137

Cointeq = LNCO2 - (-4.0622*LNAGR -1.7274*LNMAN + 4.4229*LNSER -0.3635*DUMMY + 39.8158)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-4.062169	6.515386	-0.623473	0.5469
LNMAN	-1.727445	3.785809	-0.456295	0.6579
LNSER	4.422904	7.047211	0.627611	0.5443
DUMMY	-0.363519	0.661140	-0.549836	0.5945
C	39.815819	72.047360	0.552634	0.5927

Appendix 3: Philippines

Unit Root Test: Augmented Dickey-Fuller

Level Form: Trend and Intercept

Carbon dioxide

Null Hypothesis: LNCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.323946	0.9098
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Agriculture

Null Hypothesis: LNAGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.841539	0.0645
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Manufacturing

Null Hypothesis: LNMAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.975526	0.0488
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Services

Null Hypothesis: LNSER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.716195	0.0089
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

First Different: Intercept

Carbon dioxide

Null Hypothesis: D(LNCO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.892056	0.0005
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Agriculture

Null Hypothesis: D(LNAGR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.482059	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Manufacturing

Null Hypothesis: D(LNMAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.250210	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Services

Null Hypothesis: D(LNSER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.647750	0.0001

Test critical values:	1% level	-3.679322
	5% level	-2.967767
	10% level	-2.622989

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

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	6.511836	Prob. F(1,28)	0.0165
Obs*R-squared	5.660524	Prob. Chi-Square(1)	0.0174

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	12.18841	Prob. F(2,24)	0.0002
Obs*R-squared	15.62073	Prob. Chi-Square(2)	0.0004

Newey-West Test

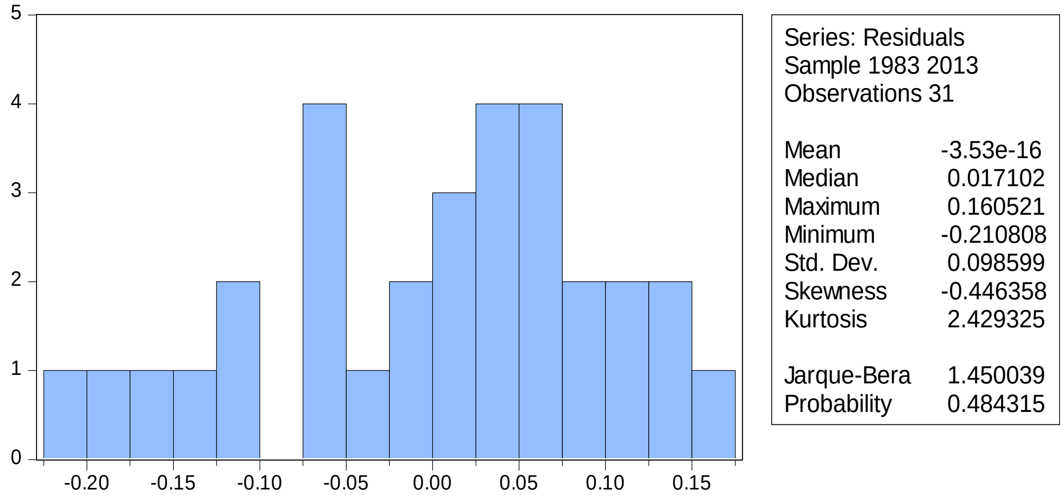
Dependent Variable: LNCO2
Method: Least Squares
Date: 06/19/17 Time: 23:54
Sample: 1983 2013
Included observations: 31
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.087608	0.293328	-0.298668	0.7676
LNMAN	-0.759676	0.533327	-1.424410	0.1662
LNSER	1.011815	0.482824	2.095620	0.0460
DUMMY	0.043686	0.038915	1.122595	0.2719
C	5.729128	3.311410	1.730117	0.0955

R-squared	0.927000	Mean dependent var	10.96250
Adjusted R-squared	0.915770	S.D. dependent var	0.364932
S.E. of regression	0.105912	Akaike info criterion	-1.505722
Sum squared resid	0.291652	Schwarz criterion	-1.274434
Log likelihood	28.33869	Hannan-Quinn criter.	-1.430328

F-statistic	82.54154	Durbin-Watson stat	0.549769
Prob(F-statistic)	0.000000	Wald F-statistic	42.80570
Prob(Wald F-statistic)	0.000000		

JarqueBera Normality Test



Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNAGR LNMAN LNSER DUMMY C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	3.743143	25	0.0010
F-statistic	14.01112	(1, 25)	0.0010
Likelihood ratio	13.79410	1	0.0002

Bound Test for Co-integration

ARDL Bounds Test
Date: 06/20/17 Time: 00:28
Sample: 1984 2013
Included observations: 30
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.053973	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

ARDL Short Run and Long Run Estimation

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 1, 1, 1, 0)
Date: 06/20/17 Time: 00:28
Sample: 1983 2013
Included observations: 30

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGR)	0.177778	0.159736	1.112947	0.2783
D(LNMAN)	0.956560	0.447207	2.138966	0.0443
D(LNSER)	-1.592421	0.585405	-2.720205	0.0128
D(DUMMY)	0.034832	0.021072	1.652966	0.1132
CointEq(-1)	-0.193482	0.104880	-1.844790	0.0792

Cointeq = LNCO2 - (2.5514*LNAGR + 0.2517*LNMAN -1.6103*LNSER + 0.1800*DUMMY -18.8139)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.

LNAGR	2.551420	1.594007	1.600633	0.1244
LNMAN	0.251666	1.912131	0.131616	0.8965
LNSER	-1.610260	2.246548	-0.716771	0.4814
DUMMY	0.180025	0.144914	1.242289	0.2278
C	-18.813878	16.510636	-1.139501	0.2673

Appendix 4: Thailand

Unit Root Test : Augmented Dickey-Fuller

Level Form: Trend and Intercept

Carbon dioxide

Null Hypothesis: LNCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.158636	0.0328
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Agriculture

Null Hypothesis: LNAGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.358789	0.9776
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Manufacturing

Null Hypothesis: LNMAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.278794	0.0251
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Services

Null Hypothesis: LNSER has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.055165	0.2632
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

First Different: Intercept

Carbon dioxide

Null Hypothesis: D(LNCO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.954502	0.0514
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Agriculture

Null Hypothesis: D(LNAGR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.757895	0.0000
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Manufacturing

Null Hypothesis: D(LNMAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.372135	0.0205
Test critical values:	1% level	-3.679322	
	5% level	-2.967767	
	10% level	-2.622989	

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

GDP in Services

Null Hypothesis: D(LNSER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.683806	0.0890

Test critical values:	1% level	-3.679322
	5% level	-2.967767
	10% level	-2.622989

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

ARCH Test

Heteroskedasticity Test: ARCH

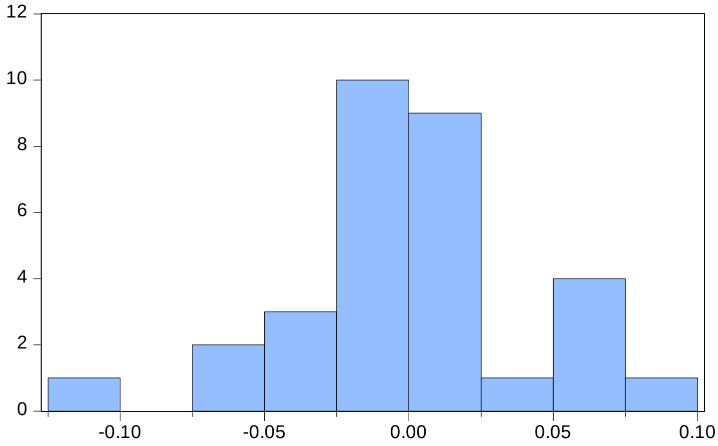
F-statistic	0.005278	Prob. F(1,28)	0.9426
Obs*R-squared	0.005654	Prob. Chi-Square(1)	0.9401

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	4.811301	Prob. F(2,24)	0.0175
Obs*R-squared	8.872028	Prob. Chi-Square(2)	0.0118

JarqueBera Normality Test



Series: Residuals	
Sample 1983 2013	
Observations 31	
Mean	-1.35e-15
Median	-0.001593
Maximum	0.099803
Minimum	-0.107865
Std. Dev.	0.042131
Skewness	0.010019
Kurtosis	3.748064
Jarque-Bera	0.723336
Probability	0.696514

Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNAGR LNMAN LNSER DUMMY C

Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.812276	25	0.0820
F-statistic	3.284343	(1, 25)	0.0820
Likelihood ratio	3.826410	1	0.0505

Bound Test for Co-integration

ARDL Bounds Test
Date: 06/19/17 Time: 18:45
Sample: 1986 2013
Included observations: 28
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	12.32825	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Short Run and Long Run Estimation

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 3, 0, 0)
Date: 06/19/17 Time: 18:47
Sample: 1983 2013
Included observations: 28

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGR)	-0.027490	0.059882	-0.459080	0.6514
D(LNAGR(-1))	0.125686	0.071279	1.763286	0.0939
D(LNAGR(-2))	0.145188	0.057808	2.511542	0.0212
D(LNMAN)	0.247856	0.099014	2.503250	0.0216
D(LNSER)	0.528010	0.125573	4.204801	0.0005
D(DUMMY)	-0.021845	0.012052	-1.812556	0.0857

CointEq(-1)	-0.749133	0.098860	-7.577727	0.0000

Cointeq = LNCO2 - (-0.4175*LNAGR + 0.3309*LNMAN + 0.7048*LNSER -0.0292*DUMMY -6.1277)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.417523	0.053602	-7.789264	0.0000
LNMAN	0.330857	0.131531	2.515440	0.0210
LNSER	0.704829	0.128766	5.473707	0.0000
DUMMY	-0.029161	0.017075	-1.707790	0.1040
C	-6.127717	0.673407	-9.099573	0.0000

Appendix 5: Vietnam

Unit Root Test : Augmented Dickey-Fuller

Level Form: Trend and Intercept

Carbon dioxide

Null Hypothesis: LNCO2 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.174961	0.9662
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

GDP in Agriculture

Null Hypothesis: LNAGR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.419671	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

GDP in Manufacturing

Null Hypothesis: LNMAN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.24242	0.0000
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

GDP in Services

Null Hypothesis: LNSER has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.074818	0.9420
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

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

First Different: Intercept

Carbon dioxide

Null Hypothesis: D(LNCO2) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.559968	0.0136
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

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

GDP in Agriculture

Null Hypothesis: D(LNAGR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.828899	0.0675
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

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

GDP in Manufacturing

Null Hypothesis: D(LNMAN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.529227	0.0149
Test critical values:	1% level	-3.699871	

	5% level	-2.976263	
	10% level	-2.627420	

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

GDP in Services

Null Hypothesis: D(LNSER) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.21255	0.0000
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

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

ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	10.12180	Prob. F(1,26)	0.0038
Obs*R-squared	7.845964	Prob. Chi-Square(1)	0.0051

White Test

Dependent Variable: LNCO2

Method: Least Squares

Date: 06/20/17 Time: 20:23

Sample (adjusted): 1985 2013

Included observations: 29 after adjustments

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.830369	0.325547	-2.550686	0.0175
LNMAN	1.707909	0.337296	5.063532	0.0000
LNSER	-0.663999	0.489090	-1.357622	0.1872
DUMMY	-0.248957	0.094636	-2.630684	0.0146
C	5.203625	2.160834	2.408156	0.0241

R-squared	0.830041	Mean dependent var	10.85436
Adjusted R-squared	0.801715	S.D. dependent var	0.758866
S.E. of regression	0.337917	Akaike info criterion	0.823554
Sum squared resid	2.740512	Schwarz criterion	1.059294
Log likelihood	-6.941529	Hannan-Quinn criter.	0.897385
F-statistic	29.30271	Durbin-Watson stat	0.495584
Prob(F-statistic)	0.000000	Wald F-statistic	53.09094
Prob(Wald F-statistic)	0.000000		

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	17.09736	Prob. F(2,22)	0.0000
Obs*R-squared	17.64662	Prob. Chi-Square(2)	0.0001

Newey-West Test

Dependent Variable: LNCO2

Method: Least Squares

Date: 06/20/17 Time: 20:24

Sample (adjusted): 1985 2013

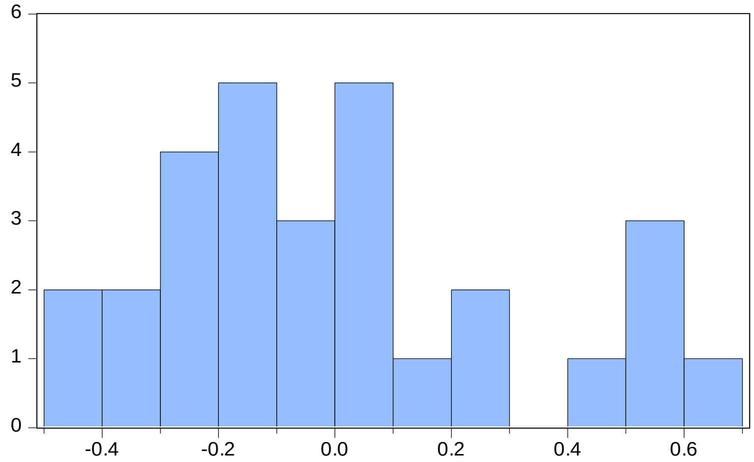
Included observations: 29 after adjustments

HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-0.830369	0.362613	-2.289958	0.0311
LNMAN	1.707909	0.439228	3.888435	0.0007
LNSER	-0.663999	0.558843	-1.188167	0.2464
DUMMY	-0.248957	0.126272	-1.971593	0.0603
C	5.203625	2.613897	1.990753	0.0580

R-squared	0.830041	Mean dependent var	10.85436
Adjusted R-squared	0.801715	S.D. dependent var	0.758866
S.E. of regression	0.337917	Akaike info criterion	0.823554
Sum squared resid	2.740512	Schwarz criterion	1.059294
Log likelihood	-6.941529	Hannan-Quinn criter.	0.897385
F-statistic	29.30271	Durbin-Watson stat	0.495584
Prob(F-statistic)	0.000000	Wald F-statistic	46.07780
Prob(Wald F-statistic)	0.000000		

JarqueBera Normality Test



Series: Residuals	
Sample 1985 2013	
Observations 29	
Mean	-1.13e-14
Median	-0.038201
Maximum	0.616235
Minimum	-0.486707
Std. Dev.	0.312851
Skewness	0.579688
Kurtosis	2.472476
Jarque-Bera	1.960440
Probability	0.375228

Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Specification: LNCO2 LNAGR LNMAN LNSER DUMMY C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.470318	23	0.0213
F-statistic	6.102473	(1, 23)	0.0213
Likelihood ratio	6.824539	1	0.0090

Bound Test for Co-integration

ARDL Bounds Test
Date: 06/20/17 Time: 19:01
Sample: 1986 2013
Included observations: 28
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.992123	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61

ARDL Short Run and Long Run Estimation

ARDL Cointegrating And Long Run Form
Dependent Variable: LNCO2
Selected Model: ARDL(1, 1, 0, 1)
Date: 06/20/17 Time: 19:02
Sample: 1983 2013
Included observations: 28

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGR)	-0.096253	0.175451	-0.548606	0.5893
D(LNMAN)	-0.274807	0.177661	-1.546806	0.1376
D(LNSER)	0.389697	0.359671	1.083484	0.2915
D(DUMMY)	-0.009460	0.034459	-0.274530	0.7865
CointEq(-1)	-0.096139	0.064577	-1.488745	0.1522

Cointeq = LNCO2 - (-5.6122*LNAGR -2.8584*LNMAN + 7.9123*LNSER -0.0984*DUMMY + 24.5442)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGR	-5.612167	3.486528	-1.609672	0.1231
LNMAN	-2.858429	3.004012	-0.951537	0.3527
LNSER	7.912335	5.679543	1.393129	0.1789
DUMMY	-0.098398	0.355008	-0.277171	0.7845
C	24.544184	19.990109	1.227816	0.2338

Appendix 6: World Bank Data

Indonesia

AGR (LCU)	MAN (LCU)	SER (LCU)	DUMMY	CO2 (kt)
-	-	-	0.000000	104956.874000
-	-	-	0.000000	112184.531000
-	-	-	0.000000	121245.688000
-	-	-	0.000000	121740.733000
2.9116E+13	2.11504E+13	5.04494E+13	1.000000	123372.548000
3.42779E+13	2.62524E+13	5.63745E+13	0.000000	132162.347000
3.91639E+13	3.03233E+13	6.59825E+13	1.000000	130966.905000
4.21487E+13	3.89102E+13	7.64127E+13	0.000000	149565.929000
4.45586E+13	4.7544E+13	8.88389E+13	0.000000	179730.671000
5.07331E+13	5.65416E+13	1.0525E+14	0.000000	202576.081000
5.89634E+13	7.35563E+13	1.39956E+14	0.000000	218600.871000
6.60715E+13	8.92407E+13	1.60806E+14	1.000000	221413.460000
7.78962E+13	1.09689E+14	1.86627E+14	0.000000	224941.114000
8.87918E+13	1.36426E+14	2.12345E+14	0.000000	253290.691000
1.0101E+14	1.68178E+14	2.48435E+14	1.000000	278658.997000
1.72828E+14	2.38897E+14	3.50656E+14	1.000000	210210.775000
2.15687E+14	2.85874E+14	4.07201E+14	1.000000	241988.997000
2.16832E+14	3.85598E+14	5.34681E+14	1.000000	263418.945000
2.51727E+14	4.78311E+14	6.29799E+14	0.000000	294907.474000
2.81591E+14	5.232E+14	7.30202E+14	0.000000	306737.216000
3.05784E+14	5.6892E+14	8.26917E+14	0.000000	316792.130000
3.29125E+14	6.44343E+14	9.42129E+14	0.000000	337635.358000
3.64169E+14	7.60361E+14	1.11893E+15	0.000000	341991.754000
4.33223E+14	9.19539E+14	1.33845E+15	0.000000	345119.705000
5.41932E+14	1.06865E+15	1.55998E+15	1.000000	375544.804000
7.16656E+14	1.37644E+15	1.85366E+15	1.000000	416560.199000
8.57197E+14	1.47754E+15	2.07753E+15	0.000000	446409.579000
9.5612E+14	1.51276E+15	2.97182E+15	0.000000	428760.308000
1.05825E+15	1.70425E+15	3.3343E+15	0.000000	573379.454000
1.15226E+15	1.84815E+15	3.70753E+15	0.000000	599539.832000
1.27505E+15	2.00743E+15	4.20103E+15	0.000000	479364.908000

Malaysia

AGR (LCU)	MAN (LCU)	SER (LCU)	DUMMY	CO2 (kt)
14245952500	13755643900	28758775600	0.000000	37971.785000
16184999900	15643256800	32154831800	0.000000	34697.154000
15712061400	15239148500	31363159000	0.000000	36237.294000
14450892800	14090629100	29054176900	0.000000	39984.968000
16185000000	16058000000	33660000500	1.000000	40762.372000
18540000000	20157000000	38400001400	0.000000	42724.217000
19028000000	25048000000	44318001500	1.000000	49882.201000
18120000000	28847000000	50711000000	0.000000	56592.811000
19398000000	34524000000	58830000000	0.000000	68591.235000
21958000000	38910000000	66726000000	0.000000	75298.178000
23740000000	44643000000	79429000000	0.000000	91722.671000
26702000000	52072000000	90493000000	1.000000	94010.879000
28810000000	58684000000	1.01553E+11	0.000000	121132.011000
29637000000	70646000000	1.13652E+11	0.000000	125374.730000
31284000000	79974000000	1.24905E+11	1.000000	124821.013000
37707000000	81525000000	1.2126E+11	1.000000	114186.713000
32610000000	93045000000	1.28421E+11	1.000000	107934.478000
30648000000	1.09998E+11	1.5354E+11	1.000000	125734.096000
28245000000	1.03434E+11	1.6143E+11	0.000000	135620.328000
34431000000	1.12076E+11	1.75892E+11	0.000000	133742.824000
38971000000	1.25331E+11	1.84742E+11	0.000000	158256.719000
43950000000	1.44006E+11	2.00044E+11	0.000000	163826.892000
44912244300	1.49754E+11	2.49017E+11	0.000000	174486.861000
51382894800	1.6451E+11	2.70308E+11	0.000000	167702.911000
66445819100	1.73804E+11	3.18019E+11	1.000000	184816.800000
76753119900	1.89105E+11	3.62766E+11	1.000000	204031.880000
65718768000	1.69661E+11	3.72949E+11	0.000000	198802.738000
82882000000	1.92494E+11	4.28051E+11	0.000000	218476.193000
1.04424E+11	2.12618E+11	4.67894E+11	0.000000	220405.035000
95122000000	2.2473E+11	5.12016E+11	0.000000	218707.214000
92830000000	2.32658E+11	5.46949E+11	0.000000	236510.499000

Philippines

AGR (LCU)	MAN (LCU)	SER (LCU)	DUMMY	CO2 (kt)
82545000000	89472000000	1.41731E+11	0.000000	35415.886000
1.29824E+11	1.29171E+11	1.95838E+11	0.000000	30993.484000
1.40554E+11	1.43851E+11	2.30781E+11	0.000000	28048.883000
1.45807E+11	1.49958E+11	2.52552E+11	0.000000	29207.655000
1.63927E+11	1.69627E+11	2.83743E+11	1.000000	32683.971000
1.83515E+11	2.04784E+11	3.3471E+11	0.000000	37729.763000
2.10009E+11	2.30163E+11	3.92471E+11	1.000000	39141.558000
2.35956E+11	2.67485E+11	4.69934E+11	0.000000	41763.463000
2.61868E+11	3.15938E+11	5.61639E+11	0.000000	43930.660000
2.94922E+11	3.26839E+11	6.12824E+11	0.000000	48752.765000
3.18546E+11	3.49595E+11	6.74011E+11	0.000000	49482.498000
3.72507E+11	3.9381E+11	7.69716E+11	1.000000	54799.648000
4.12197E+11	4.38247E+11	8.82657E+11	0.000000	60710.852000
4.47803E+11	4.95389E+11	1.02724E+12	0.000000	62162.984000
4.57983E+11	5.40305E+11	1.18897E+12	1.000000	71158.135000
4.35823E+11	6.92597E+11	1.50148E+12	1.000000	69240.294000
4.93479E+11	7.61326E+11	1.67832E+12	1.000000	69159.620000
5.00111E+11	8.76107E+11	1.84683E+12	1.000000	73306.997000
5.1341E+11	9.59245E+11	2.03378E+12	0.000000	71051.792000
5.51897E+11	1.03667E+12	2.1945E+12	0.000000	71337.818000
5.77804E+11	1.12077E+12	2.39843E+12	0.000000	71532.169000
6.81296E+11	1.22626E+12	2.71086E+12	0.000000	74066.066000
7.19076E+11	1.36569E+12	3.03766E+12	0.000000	74832.469000
7.75688E+11	1.48132E+12	3.39509E+12	0.000000	67692.820000
8.61365E+11	1.5677E+12	3.7531E+12	1.000000	72170.227000
1.02251E+12	1.76089E+12	4.15993E+12	1.000000	78858.835000
1.04987E+12	1.70639E+12	4.43116E+12	0.000000	77568.051000
1.10872E+12	1.93078E+12	4.96248E+12	0.000000	84920.386000
1.23501E+12	2.04772E+12	5.43003E+12	0.000000	85584.113000
1.24977E+12	2.17092E+12	6.01137E+12	0.000000	91319.301000
1.29836E+12	2.35542E+12	6.64979E+12	0.000000	98238.930000

Thailand

AGR (LCU)	MAN (LCU)	SER (LCU)	DUMMY	CO2 (kt)
1.84752E+11	2.03837E+11	4.54569E+11	0.000000	42452.859000
1.73642E+11	2.2636E+11	4.98489E+11	0.000000	45973.179000
1.67026E+11	2.31598E+11	5.53056E+11	0.000000	48672.091000
1.77537E+11	2.70605E+11	5.80899E+11	0.000000	49702.518000
2.04521E+11	3.15291E+11	6.6196E+11	1.000000	56944.843000
2.52346E+11	4.03034E+11	7.68078E+11	0.000000	67003.424000
2.79947E+11	4.96714E+11	9.03857E+11	1.000000	78891.838000
2.72935E+11	5.94003E+11	1.09779E+12	0.000000	90805.921000
3.17085E+11	7.07901E+11	1.22054E+12	0.000000	99782.737000
3.48127E+11	7.78987E+11	1.40546E+12	0.000000	109778.979000
2.61984E+11	8.61835E+11	1.7914E+12	0.000000	124949.358000
3.18333E+11	9.64314E+11	1.99756E+12	1.000000	139158.983000
3.83075E+11	1.11626E+12	2.25181E+12	0.000000	161153.649000
4.20493E+11	1.20254E+12	2.48691E+12	0.000000	180255.052000
4.27075E+11	1.25811E+12	2.55061E+12	1.000000	185916.900000
4.82495E+11	1.28639E+12	2.51311E+12	1.000000	164347.606000
4.26094E+11	1.35974E+12	2.61315E+12	1.000000	176126.010000
4.31082E+11	1.4496E+12	2.77104E+12	1.000000	181270.811000
4.58736E+11	1.49847E+12	2.93711E+12	0.000000	194600.356000
5.01724E+11	1.65683E+12	3.13052E+12	0.000000	208322.270000
5.96642E+11	1.88087E+12	3.31642E+12	0.000000	224574.414000
6.46342E+11	2.05875E+12	3.66334E+12	0.000000	243188.106000
7.00379E+11	2.26862E+12	3.97266E+12	0.000000	247467.495000
7.90176E+11	2.54851E+12	4.31156E+12	0.000000	255021.515000
8.4869E+11	2.79078E+12	4.63829E+12	1.000000	255303.874000
9.78016E+11	2.98098E+12	4.88638E+12	1.000000	255358.879000
9.45605E+11	2.86019E+12	4.96978E+12	0.000000	270419.248000
1.13758E+12	3.35827E+12	5.34019E+12	0.000000	288589.233000
1.31099E+12	3.29433E+12	5.68467E+12	0.000000	290342.059000
1.42196E+12	3.47382E+12	6.30192E+12	0.000000	305222.745000
1.46989E+12	3.57188E+12	6.66074E+12	0.000000	303117.887000

Vietnam

AGR (LCU)	MAN (LCU)	SER (LCU)	DUMMY	CO2 (kt)
-	-	-	0.000000	19317.756000
-	-	-	0.000000	17550.262000
4.7E+10	24000000000	38000001000	0.000000	21165.924000
2.28E+11	1.34E+11	1.98E+11	0.000000	23091.099000
1.164E+12	6.42E+11	8.92E+11	1.000000	25969.694000
7.139E+12	2.784E+12	4.586E+12	0.000000	23182.774000
1.1818E+13	4.257E+12	9.831E+12	1.000000	17509.925000
1.6252E+13	5.142E+12	1.619E+13	0.000000	21407.946000
3.1058E+13	1.0051E+13	2.7397E+13	0.000000	21451.950000
3.7513E+13	1.7015E+13	4.2884E+13	0.000000	21477.619000
4.1895E+13	2.1275E+13	5.7828E+13	0.000000	23006.758000
4.8968E+13	2.6624E+13	7.8026E+13	1.000000	26230.051000
6.2219E+13	3.4318E+13	1.00853E+14	0.000000	29090.311000
7.5514E+13	4.1291E+13	1.15645E+14	0.000000	34667.818000
8.0826E+13	5.17E+13	1.32203E+14	1.000000	45100.433000
9.3068E+13	6.1906E+13	1.50645E+14	1.000000	47513.319000
1.0172E+14	7.0767E+13	1.6026E+14	1.000000	47693.002000
1.0836E+14	8.147E+13	2.0526E+14	1.000000	53644.543000
1.1186E+14	9.4621E+13	2.23538E+14	0.000000	61139.891000
1.2338E+14	1.09601E+14	2.49449E+14	0.000000	70806.103000
1.3828E+14	1.24698E+14	2.81271E+14	0.000000	78767.160000
1.5599E+14	1.45475E+14	3.30801E+14	0.000000	90549.231000
1.764E+14	1.72045E+14	3.8908E+14	0.000000	98143.588000
1.988E+14	2.05739E+14	4.53166E+14	0.000000	102745.673000
2.3259E+14	2.41629E+14	5.34032E+14	1.000000	104872.533000
3.2989E+14	3.00256E+14	6.86968E+14	1.000000	117993.059000
3.4679E+14	3.31093E+14	7.85954E+14	0.000000	134916.264000
3.9658E+14	2.7936E+14	7.97155E+14	0.000000	147340.060000
5.4396E+14	3.71242E+14	1.02113E+15	0.000000	161887.049000
6.2382E+14	4.31144E+14	1.20946E+15	0.000000	158231.050000
6.4386E+14	4.77968E+14	1.38841E+15	0.000000	152624.207000