Faculty of Economics and Business

MACROECONOMICS DETERMINANTS OF CO_2 EMISSION: EMPIRICAL STUDY OF MALAYSIA

Simon Hiew Xi Zen

62528

Bachelor of Economics with Honours

(Business Economics)

2020

MACROECONOMICS DETERMINANTS OF CO_2 EMISSION: EMPIRICAL STUDY OF MALAYSIA

By

Simon Hiew Xi Zen

This project is submitted in fulfilment of the requirements for the degree of

Bachelor of Economics with Honours

(Business Economics)

Faculty of Economics and Business

UNIVERSITI MALAYSIA SARAWAK

2020

STATEMENT OF ORIGINALITY

The work described in this Final Year Project entitled

"MACROECONOMICS DETERMINANTS OF CO_2 EMISSION: EMPIRICAL STUDY OF MALAYSIA"

Is to the best of the researcher's knowledge that of the researcher except where due reference is hereby being made.

……………………… ……………………………..

Date of Submission

Simon Hiew Xi Zen
62528

ABSTRACT

MARCOECONOMICS DETERMINANTS OF CO_2 EMISSION: EMPIRICAL STUDY OF MALAYSIA

By

Simon Hiew Xi Zen

Malaysia is one of the developing countries that had recorded highest CO_2 emissions in Association of Southeast Asia Nation (ASEAN) region. The purpose of this study aiming to investigate the relationship between CO_2 emissions and its macroeconomics variables by using the data from year 1980 to 2018. The dependent variable will be CO_2 emissions while GDP per capita, foreign direct investment (FDI), population growth, electricity production and industrial structure will act as independent variables. However, Autoregression Distributed Lag Cointegration (ARDL) approach had been used to identify the cointegration relationship and forecast the long run equilibrium of the variables. This study found out that all of the variables have short run relationship and long run relationship towards CO_2 emissions through econometric analysis. However, population growth is one of the main contributors towards high CO_2 emissions due to increase production and consumption. Thus, this study is important in reducing CO_2 emissions to prevent further human destruction activity that lead to environmental degradation.

ABSTRAK

PENENTU PEMBOLEH UBAH MAKROEKONOMI DAN EMISI KARBON DIOKSIDA: KAJIAN EMPIRIKAL DI MALAYSIA

Oleh

Simon Hiew Xi Zen

Malaysia merupakan sebuah negara membangun yang mempunyai catatan emisi karbon dioksida yang tertinggi dalam Persatuan Negara-negara Asian Tenggara (ASEAN). Kajian ini akan mengkaji hubungan antara karbon dioksida dan pemboleh ubah makroekonomi dengan mengunakan data dari tahun 1980 ke 2018. Dalam kajian ini, emisi karbon dioksida akan dijadikan sebagai pemboleh ubah dimanipulasi, manakala bagi Keluaran Dalam Negara Kasar (KDNK) per kapita, pelaburan langsung asing, perkembangan populasi, struktur industri dan pengeluaran elektrik bertindak sebagai pemboleh ubah bergerak balas. Selain itu, penggunaan kaedah *Autoregression Distributed Lag Cointegration (ARDL)* bertujuan untuk mengenal pasti hubungan kointergrasi and meramalkan keseimbangan hubungan jangka panjang antara pemboleh ubah. Kajian ini mendapati bahawa semua pemboleh ubah mempunyai hubungan jangka panjang dan jangka pendek. Selain itu, perkembangan populasi merupakan penyumbang utama kepada peningkatan emisi karbon dioksida kerana ia membawa peningkatan pengeluaran dan penggunaan. Oleh itu, kajian ini adalah penting untuk membantu mengurangkan emisi karbon dioksida demi mencegah pemusnahan daripada aktiviti manusia yang menyebabkan pencemaran alam sekitar.

ACKNOWLEDGEMENT

First and foremost, I would like to praise and thanks to God for the blessings and success throughout my Final Year Project. I also would like to show my appreciation to Him for the good health and wellbeing especially during this Covid-19 pandemic as well as to complete my Final Year Project.

I cannot express deeply enough and sincere gratitude to my supervisor, Dr. Jerome Kueh to give me an opportunity to conduct this research and providing guidance, encouragements, comments, tolerance and supervision throughout my research. He has taught me correct and suitable methodology to carry out the research and present my research works as simple, as informative and as clearly as possible. It was a great experience and honour to work and study under his supervision. I am extremely thankful and grateful for his time, expertise and knowledge he had offered. I also would like to thank to him from bottom of my heart for his friendship, empathy, kindness as well as great sense of humour.

I also highly indebted to all of the lecturers and staff in Faculty of Economics and Business, UNIMAS for sharing their experience, knowledge, sincere, expertise and valuable guidance and encouragement throughout my years of study.

I am extremely grateful to both of my parents for their love, caring and supports for educating me to have a right path in the future. Throughout this study, they have been sacrificed their energy, time and sweat to ensure I able to conduct and complete my research successfully. I also wanted to take this opportunity to thanks my friends for the support and unwavering moral, positive emotional, encouraging, patience and understanding throughout my years of study.

LIST OF TABLES

Table 2. 1 Summary of Literature Review..42

Table 3. 1: Null hypothesis and Alternative hypothesis of Granger Causality..........67

Table 3. 2: Macroeconomics Variables Expected Sign and Used by Previous 70

Table 4. 1: Results of ADF, PP and KPSS Test..74

Table 4. 2: Results of ARDL Bound Test...76

Table 4. 3: Results of Error Correction Model 77

Table 4. 4: Results of Diagnostic Tests...79

Table 4. 5: Results of Granger Causality 81

Table 4. 6: Results of Variance Decomposition..82

LIST OF FIGURES

Figure 1. 1: Malaysia GDP Growth (%) from year 1980 to 2018................................8

Figure 1. 2: Malaysia's CO_2 Emission 11

Figure 2. 1: Relationship between income level and environmental degradation based on EKC Hypotheses 24

Figure 4. 1: CUSUM Test ....………………………………………………………80

Figure 4. 2: $CUSUM^2$ Test...80

Figure 4. 3: Granger Causality Channel Among Variables 81

TABLE OF CONTENTS

CHAPTER ONE : INTRODUCTION

1.1 Introduction 1

1.2 Background of Study 7

1.2.1 Malaysia's Growth Domestic Product (GDP) 7

1.2.2 Malaysia's CO_2 Emissions 10

1.3 Motivation of Study 13

1.4 Problem Statement 14

1.5 Objective of Study 18

1.5.1 General Objective 18

1.5.2 Specific Objective 18

1.6 Significant of Study 19

1.7 Organization of Study 21

CHAPTER TWO : LITERATURE REVIEWS

2.1 Introduction 22

2.2 Theoretical Framework 24

2.2.1 Income Per Capita 24

2.2.2 Foreign Direct Investment (FDI) 26

2.2.3 Population Growth 27

2.2.4 Electricity Production from Oil, Gases and Coal Source 29

2.2.5 Industrial Structure....30

2.3 Empirical Finding....32

2.4 Literature Gap....38

2.5 Concluding Remark....41

CHAPTER THREE : METHODOLOGY

3.1 Introduction....54

3.2 Empirical Model....55

3.3 Methodology....56

3.3.1 Unit Root Tests....56

3.3.2 Autoregressive Distributed Lag Model (ARDL) Approach....59

3.3.3 Error Correction Model (ECM)....61

3.3.4 Diagnostic Tests....62

3.3.5 Granger Causality....66

3.3.6 Variance Decomposition....68

3.4 Data Description....69

CHAPTER FOUR : RESULTS AND DISCUSSION

4.1 Unit Root Test....74

4.2 ARDL Approach....76

4.2.1 ARDL Bound Tests for Long-Run Cointegration Analysis....76

4.3 Error Correction Model (ECM)....77

4.4 Diagnostic Tests....79

4.4.1 Jarque-Bera Normality Test 79

4.4.2 Breusch-Godfrey Serial Correlation LM Test 79

4.4.3 Auto Regressive Conditional Heteroskedasticity (ARCH) Test 79

4.4.4 Ramsey RESET Test 80

4.4.5 CUSUM Test and CUSUM^2 Test 80

4.5 Granger Causality / Block Exogeneity Wald Tests 81

4.6 Variance Decomposition 82

CHAPTER FIVE : CONCLUSION AND RECOMMENDATION

5.1 Introduction 84

5.2 Summary of the Study 84

5.3 Recommendations and Policy Implementation of the Study 89

5.4 Limitations of The Study 92

Reference 94

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The aim of study is to examines the relationship and impact between greenhouse gas which is carbon dioxide emission (CO_2 emission) and determinants of macroeconomics variables in Malaysia. CO_2 emission is one of the greenhouse gases that produce by both nature activities and human activities. However, human activities are the greatest contributor of CO_2 emission to the environment compared to nature activities. Malaysia recorded as one of the highest CO_2 emission within the ASEAN countries which consist of 10 members states. In 2019, Malaysia with a population of 32 million people have recorded the highest CO_2 emission per capita which at 7.27 tonnes that double than Thailand with 3.64 tonnes and slightly higher than China with 6.59 tonnes. The situation such as increase in the number of populations, boosting in economic growth, rising in income per capita, higher energy production and consumption such as electricity and industrialization in Malaysia will led to more less desirable outcome of uncontrollable of CO_2 emission. This uncontrollable CO_2 emission will cause negative impacts towards both environmental quality and human health. When the rising in the concentration of greenhouse gases in atmosphere over time it will trap the reflected heat of ultraviolet that need to pass through ozone layer and back into the space. This will cause the temperature on earth keep on increasing which led to problem of global warming and serious climate change.

Previously, many researchers have conducted a study on the relationship between macroeconomics variables and CO_2 emission for different countries. It is important to study the correlation of macroeconomics variables towards CO_2 emission.

This is because to identify the variables that have positive relations towards CO_2 emission should be reduce by taking and implementing suitable and effective solutions. Based on the study, many researchers have explained the validity of Environment Kuznets curve (EKC) or inverse-U shaped curve. The hypothesis stated that when the economic growth indicator increase, the greenhouse gases (GHGs) will increase at first stage then decline at turning points. According to Wang et al. (2016), they depict that economic growth is a significant driving impact factors toward CO_2 emissions growth. Shao et al. (2016) said that the effect of economic scale is main contributor increases in CO_2 emissions. Alkhathlam and Javid (2013) have conducted a study in Saudi Arabia, the results of their study projected a positive long-run relationship between CO_2 emissions, economic growth and energy demands. Although there is an uncertainty on improper implementation towards reducing excessive CO_2 emission, the solution such as trading of GHGs is one of important tools to caught the problem of global warming. According to Oh and Chua (2010), GHGs trade has applied and practiced by some countries including Malaysia. Once the GHGs trade applied and practiced towards the low carbon economy, various type of policies and initiatives had been implemented and enforced to achieve the goal of low carbon economy.

However, the study evidenced that CO_2 emissions are determined by macroeconomics variables. Wang et al. (2013) depict that population, level of economic, and level of industrialization significantly impacts on CO_2 emission in China. Yet, the population is the most dominant influence variable towards CO_2 emissions. According to Guo et al. (2015), they forecasted that impact of population structures such as age, education, and occupation negatively influence CO_2 emissions, while population change in urban and rural are positively affects CO_2 emissions.

According to Wang et al. (2016a), they forecasted a positive correlation between energy consumption in China and CO_2 emissions. Next, the study conducted by Salahuddin et al. (2013) shows that there is a significant negative correlation between CO_2 emissions and financial development. Omri et al. (2014) investigate causal relationship between foreign direct investment (FDI) and CO_2 emissions which their finding shows the bidirectional causal relationship between series. Thus, the study conducted by different researchers will provide different results.

Besides that, number of years many researchers had concentrated on CO_2 emissions especially in developing countries that give different type of results. For instances in Turkish, Bozkurt and Akan (2014) stated that the CO_2 emissions and economic growth is negatively correlated. The results same found by Lim et al. (2014) in Philippines. The idea from the previous study also mentioned that the economic growth and energy consumption are closely related. According to Hwang and Yoo (2014), they use data with annual period from 1965 to 2006 shows there was bidirectional granger causality between the energy consumption and CO_2 emissions. However, many of researchers argued that the industrial structure also one of the important factors that cause CO_2 emissions. A different structure will practice different operating activities that will affect the CO_2 emissions. On other side, according to Shahbaz and Leitao (2013) mentioned that international trade also will positive impact on CO_2 emissions.

In different type of greenhouse gases, carbon dioxide is one of the largest components that contributed to global warming and climate change. A developing country that involved in industrial revolution such as Malaysia, socioeconomics activities have contributed significantly to climate change due to increase in CO_2

emissions and other greenhouse gases into the atmosphere. Increase in concentration of CO_2 emissions led to greenhouse effects that cause the temperature on earth to rise. The growing industrialization in Malaysia cause the ecological environment quality worsened and stimulate global warming. The common human activities such as process of burning fossil fuels, open burning by agriculture activities, and other activities that involve combustion will produce large amount of CO_2 emissions into atmosphere. For examples in industrialize country, CO_2 emissions almost increase about 40% compared to pre-industrial revolution times. This is because industrialize country established a lot of development activities to increase the GDP and people wellbeing. Produced CO_2 gases will absorb heat on earth and urban heat island (UHI) will formed. Therefore, it is interest to study the correlation between macroeconomics variables and CO_2 emissions in Malaysia since the existed policies and solutions still uncertainly reduce CO_2 emissions.

The general objective of study is to examine the correlation between CO_2 emissions and surveyed macroeconomics variables. There are four specific objectives in this study. First is to examine whether the CO_2 emissions and macroeconomics variables related in a long-run and second whether the CO_2 emissions and macroeconomics variables related in a short-run in Malaysia. Third is to identify the exogenous macroeconomics variables that contribute to CO_2 emissions and lastly is to identify the endogenous macroeconomics variables that contribute to CO_2 emissions.

Basically, there are six macroeconomics variables which consist of GDP per capita, FDI, population, industrial structure and electricity production. The study is focus on CO_2 emissions and it is determinants in Malaysia. The reason to select CO_2 emissions issues in Malaysia because the problem of CO_2 emissions will keep on increasing and getting higher in the future although Malaysia have implementing various policies such as green technology, several policies, environmental campaigns and eco-friendly lifestyle. But those solutions did not sufficiently help in CO_2 emissions reduction. The data of the variables obtained covering for period of 39 years. The period of data is from January 1980 to December 2018 which has been selected in this study. The data was obtained from two sources; Global Cardon Atlas for CO_2 emissions and World Development Indicator (WDI) for its determinants.

This study contributes to the literature in two ways. Firstly, the finding of the study is meaningful to the policy makers. The study will investigate the correlation between CO_2 emissions and macroeconomics. The results of the study will provide useful information on the variables that have major impact on CO_2 emissions and come out with effective recommendations towards CO_2 emissions reduction. Secondly, the study will provide information and knowledge on the relationship of CO_2 emissions and its macroeconomics variable for the purpose of public knowledge on Malaysia environmental degradation. The study also involved the macroeconomics variables that impact on CO_2 emissions in short-run and long-run. Through the information, the recommendation of solutions and policies from this study could contribute to policy maker in achieving the reduction of CO_2 emissions in Malaysia and become more stricter towards environmental quality. Besides that, the information, results and finding of this study also contribute to public understanding by deeper their knowledge about the way of macroeconomics variables affects CO_2 emissions in Malaysia. Thus, policy maker and public can take actions towards CO_2 emissions reduction which its good for quality of environment.

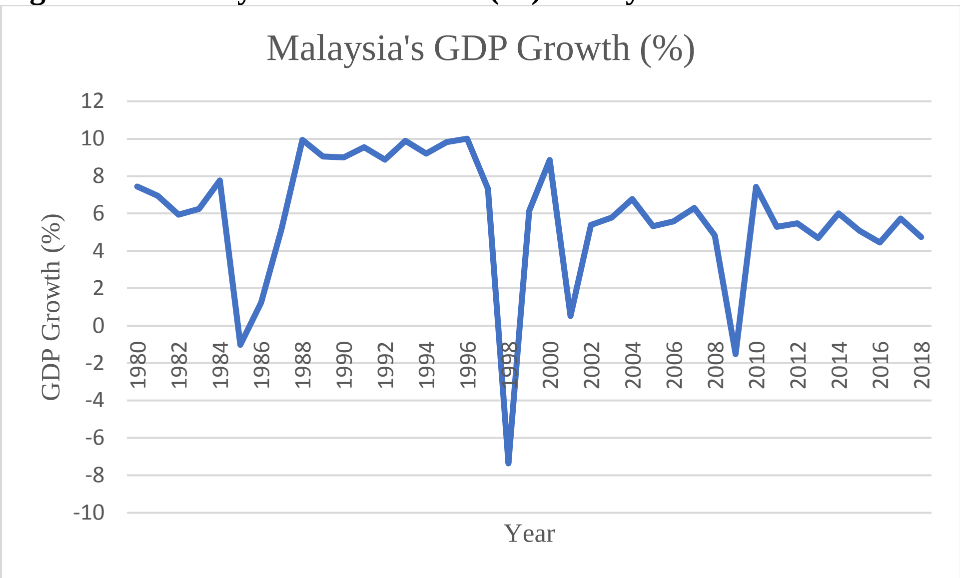
The remainder of this study is organized as following: In Section 1.1 will provides introduction of this study. In Section 1.2 states the background of the study, while in Section 1.3 mentions the motivation of this study. The problem statement, objective of study and significant of study are given in Section 1.4, 1.5 and 1.6 respectively. Lastly, Section 1.7 reviews organization of study.

1.2 Background of Study

1.2.1 Malaysia's Growth Domestic Product (GDP)

Malaysia considered as the federal constitutional monarchy country which located within Southeast Asia that consists of thirteen states as well as three federal territories include Kuala Lumpur, Putra Jaya and Labuan. Recently, Malaysia become one of the newly industrialized country (NIC) at which the economy is focus on industrial development that lead to constant increase in CO_2 emissions. The uncontrollable of increases in CO_2 emissions will lead to environmental degradation via air pollution that would cause more negative externalities towards environment quality and humans health. However, various solutions and policies had been implemented by the authority to meet the CO_2 emissions reduction such as ratification of Montreal Protocol, ratification of Kyoto protocol, establishment of green and environmental-friendly technology, ratification of Doha Amendment to Kyoto Protocol and others. Although these actions have been taken, but the problem did not take seriously to meet the CO_2 emissions reduction. Therefore, this study conducted will support in achieving the CO_2 emissions reduction in long run.

Figure 1. 1: Malaysia GDP Growth (%) from year 1980 to 2018



Source: World Development Indicator Database (2019)

The Figure 1.1 shows Malaysia GDP growth data from year 1980 to 2018. The Malaysia GDP growth have consistently decline from 7.442% to 5.943% for the year 1980 until 1982. The next following two years, GDP grow start to increase from 6.252% to 7.762%. In year 1985, Malaysia economic have faced great recession at which GDP growth sharply decrease to -1.025% due to deterioration of electronic sector negative affect Malaysia economics (Treasury Malaysia, Ministry of Finance, 2010).

Moreover, after the recession period, Malaysia live in golden age for a decade. In year 1986 until 1988, the GDP growth was greatly boomed from 1.241% to 9.938% and the percentage sustained until 1996 which recorded at 10.003%. The Foreign Direct Investment (FDI) reported was increased almost fourfold due to higher interest rate that able to attract foreign investors (Prof. Dr. Mahani, University of Malaya, 2002). However, Malaysia faced the worse economic recession for the first time in economic history in year 1997 and 1998. The situation of financial crisis hit Malaysia during July 1997 because the first major fall was the stock price (Hasan, 2002). During middle of 1997, Malaysia faced critical financial crisis which started from Thailand. The Thai Baht was having speculative attacks that give severe pressure to Malaysia Ringgit. The Bank Negara Malaysia (Malaysia Central Bank) quick response to involve in foreign exchange market to uphold value of Malaysia ringgit for period of one week before the ringgit finally float on July 14. At the same time, the bank already lost about US$1.5 billion just to prop up ringgit. The value of the ringgit already at the lowest point which depreciated by almost 50%.

However, there was an extreme decrease in exchange rate which it was the unfortunate period of stock market collapse. The composite index of the Kuala Lumpur stock exchange fell by 44.9% during the period between July to December 1997. Next, index started to drop again to 11-year low of 262.70 points during September 1998. After that, there was a slightly recovery in first quarter of 1999. As an overview, between the July 1997 to September 1998, the market capitalization in Kuala Lumpur stock exchange drop almost 76% which to RM181.5 billion. Although the problem of pre-crisis economic fundamental faced among countries, Malaysia is the one experienced largest stock market plunge in the region. Therefore, this problem also negatively impacted on Malaysia GDP growth which reported sharply decline from 7.323% to -7.359% for year 1997 and 1998.

Towards into 21st century, the GDP growth begins to increase again from year 1999 to 2000 which recorded at 6.138% to 8.859% respectively and it started to reduce to 0.518% at year 2001. For the next following year, Malaysia able to sustain the GDP growth from year 2002 to 2008. But in year 2009, Malaysia once again face recession at which GDP growth drop until -1.514% and Malaysia able to recover the recession for the following year. Malaysia able to maintain the GDP growth above 4% for 5 years (2010 to 2014) after faced three great recession. Although the GDP growth were greater than 4%, it still dropped from 5.092% in 2015 to 4.742% in 2018 which about drop about 0.350%.

1.2.2 Malaysia's CO_2 Emissions

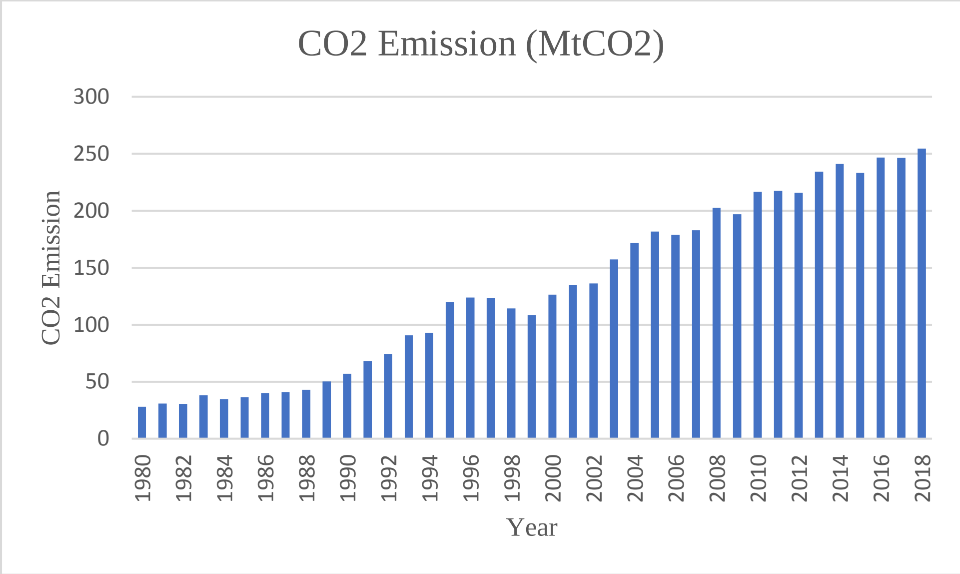
Before reviews the background of study on Malaysia CO_2 emission for the time series of 1980 to 2014, the crisis issue of CO_2 emission will be highlighted to understand the critical of CO_2 emission in Malaysia faced currently. Therefore, it is important to know the problem of CO_2 emission experience by Malaysia before knowing the trend of CO_2 emission.

So, the energy production in Malaysia was greatly increase for last few decades which contributed to high amount of CO_2 emission. In year of 2009, the Malaysia's Prime Minister, Dato' Sri Mohd Najib Tun Razak launched a policy called national green technology policy that concern with the issues of increase in energy production and CO_2 emission. The national green policy implemented aim to ensure the sustainable real GDP at the same time increase in energy production can reduce CO_2 emissions produces by various industrials and sector into the air (UNFCCC, 2009).

In fact, according to Climate Change Performance Index Report (2012), the indicator of climate change performance index shows very poor result and Malaysia ranked at 49^{th} out of 61 biggest countries that contribute to most polluted environments. Moreover, the Malaysia's CO_2 emission recorded yearly growth rate of 4.6% for 1971 to 2012. These pattern shows that Malaysia government are relaxed into the pattern of continuous growth in CO_2 emission. Malaysia are still faced the problem of uncertainty in proper implementation of policy towards CO_2 emission reduction.

Next, the Malaysia's CO_2 emissions for annual time period from 1980 to 2014 is shown in Figure 1.2.

Figure 1. 2: Malaysia's CO_2 Emission



Source: World Development Indicator Database (2019)

Based on Figure 1.2, from 1980 to 1994, CO_2 emissions produced in Malaysia was slowly increase from 28.032mt to 92.995mt for 15 years. Within that years, Malaysia have implemented three solutions towards CO_2 emissions reduction. In year 1989, Malaysia have signed the ratification of Montreal Protocol towards reduction of production of ozone depleting substances (ODS) which it had different timetables developed countries. Malaysian also have participated in Earth Summit in year 1992 in the purpose to shift region attitude towards environment friendly. Malaysia also signed the ratification of United Nations Framework Convention on climate change (UNFCCC) that have identical objective towards environment. Thus, these solutions have slowed down the increase of CO_2 emissions for 15 years.

However, from Figure 1.2, there was an increasing in CO_2 emissions for year 1995 until 1997 which recorded from 119.979mt to 123.613mt then it started to reduce to 114.238mt following year. In the year of 1997, Malaysia have faced one of the worst

Asian financial crisis. This is because the Thai baht or Thailand currency hit by big attacks and pegged Central Bank to deplete its reverse and protects Thailand currency. Malaysian Prime Minister, Dr Mahathir implemented very strict financial regulations to protect the outflow of capital and fix Malaysian currency. Obviously during the financial crisis, a lot of industrial and agricultures activities have to conducted to survived in worst economic situation. Those CO_2 emissions was produced from burning fossil fuels and manufacture of cements.

The CO_2 emissions produced by Malaysia started to increase constantly from 1999 until 2018 which recorded at 108.291mt until 254.527mt respectively. This is because Malaysia started to transform in Newly Industrialized Country (NIC) which Malaysia as developing country towards developed country. Malaysia has focused on export of goods and services that many industries will produce a lot of CO_2 emissions into the atmosphere uncontrollable. Export of palm oil to the western countries cause Malaysia need to keep on planting and harvesting *arecaceae* tree or palm tree. During harvesting process, the workers will establish an open burning activity to clear the land and start to replant new young *arecaceae*. Thus, the CO_2 emissions in Malaysia was constantly increase since 1999 until Malaysia achieve the highest amount of CO_2 emissions in 2014 compared to previous three decades.

1.3 Motivation of Study

In this study, there are two factors of motivation. This study unlike other previous studies which most of the study conducted is cross sectional or panel data study that involved Malaysia. There also few studies on Malaysia's CO_2 emissions at which does not include the total population of nation and industrial structure. Firstly, Firstly, this study focuses to discover the interaction between CO_2 emissions and macroeconomics variables in Malaysia. Malaysia as a developing country and listed in NIC, human activities such as industrialization, burning fossil fuels, increase in population in urban and rural areas led to rising in CO_2 emissions produced uncontrollable into atmosphere. Secondly, the finding of this study will help and provide additional information and solutions regarding on CO_2 emissions reduction as well as increase the knowledge and awareness of society towards the problem of CO_2 emissions in Malaysia. Hence, both parties could coperated in reducing the CO_2 emissions production in Malaysia.

Basically, previous study had been conducted on CO_2 emissions by Mugableh (2013) and Amran et al (2013), there were fewer studies to examine the relationship between CO_2 emissions and macroeconomics variables in Malaysia. Therefore, this study will focus in one developing county which is Malaysia that have emitted CO_2 gas into atmosphere uncontrollable. Based on the finding of study, most of policy maker can identify which of macroeconomics variables that contribute to CO_2 emissions. Thus, policy maker can come out with the effective solutions towards greenhouse gases reduction.

1.4 Problem Statement

The study on the relationship of macroeconomics variables and CO_2 emissions is one of the famous topics studied among the academics especially for cross sectional and panel data research. Malaysia located at Southeast Asian is a developing country that consist of peninsular Malaysia and East Malaysia. A country like Malaysia is a developing country that highly depending on the industrial development and agricultural production which cause highly CO_2 emitted to atmosphere. During the development progress experienced by Malaysia and other Southeast Asia countries continuously for decades and uncertainty in proper management, the problem of climate change and global warming will become more worse. The problem of CO_2 emissions produced by human activities will remain in the atmosphere for long period of time compared to other greenhouse gases such as methane and nitrous oxide. The CO_2 emissions in Malaysia projected will increase continuously in the future which will negatively impacts on both human health and environmental quality.

The most important variable that cannot be ignore is the income per capita. According to Mikayilov et al. (2018), there is a positive and significant correlation between income per capita and CO_2 emissions. However, CO_2 emission in Malaysia are growing at an increasing rate due to raising in standard of living among the people when their income level increase with industrial production. The trends reveal the patterns of growing in GDP in Malaysia which also means that economic development stages as Malaysia moved from low-income to high-income level. The potential increase in economic growth and income growth will contribute more problems towards significant future growth of emission. This is because currently Malaysia is considered at the early phase of EKC whereas increase in income level lead to increase in CO_2 emission. This is because the Malaysia are still going through the developing stage and experiencing industrialization process which most of the sectors' production increase together with income level. When Malaysia at this stage and does not fully implement and practice green technology policies, the CO_2 emission will keep on increasing until proper policies implementation. The CO_2 emission shows continuously increase from time to time that caused by three major sectors such as agriculture, manufacturing and services which lead to increase in GDP and also play important role to drive CO_2 emission to higher level in future (Ling et al., 2017).

One of the massive factors contribute towards CO_2 emission in Malaysia is from the burning of fossil fuels and climate impacts become important scientific and political issues. Besides, electrical production is the main industry identified that produce CO_2 emission in Malaysia. According to Safaai et al. (2011), they use Long-Range Energy Alternatives Planning System (LEAP) to forecast the CO_2 emission in future and their finding shows with amount of 285.73 million tonnes of CO_2 gas will be produced in 2020, which indicates increase of 68.86% compared with amount CO_2 gas emitted in 2000. Despites from that, electricity production also contribute 43.40% out of total emissions which it is the largest emitting sector compared to all other sectors such as transportation, industrial and residential. This is because in Malaysia is a country that highly depends on resources to generate electricity which increase in production is because of increase in human daily basic activities. The largest the consumption of electricity, the more natural resources such as oil, gas fossil and coals will be used to produce it. Therefore, government should change action to be more effective in using energy efficiently to reduce future CO_2 emissions and associated impact in Malaysia. Therefore, in this study the electricity production will be an important variable that contribute to CO_2 emission.

Besides that, there also a huge increase in Malaysia population which multiplied in order of 11 times throughout 110 years compared to other Southeast Asia which recorded only around 7-fold increase (Hezri, Idrus and Hadi, n.d). The important features in Malaysia's history is the rapid urbanisation which raising from 26.8% to 70.9% in 1970 and 2010 respectively (Abdul Rahman and Prema, 2014). However, Malaysia future seems more challenging since the small towns or cities increase in individual boundaries to combine into each other and create huge conurbation of urban centres or mega-urban regions. The natural ecosystems increasingly replaced by urban regions due to increase in population in Malaysia which give negative impacts such as increase in CO_2 emission from intensive material flows, huge changes in land use and others. Hence, in this study also will considered population is one of the major contributions of CO_2 emission.

Malaysia have implemented three principal policies include National Development Policy, Vision 2020 Five-yearly Development Plans and National Environmental Policy which are the important factors for national development planning and implementation of environmental protection policies to reduce CO_2 emission. Besides that, Malaysia also signed various international agreements towards environmental conservation such as Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Disposal, Climate Change and Biodiversity Convention 1992, Brundtland Report 1987 United General Assembly Resolution 44/228 and Earth Summit. The procedure of these documents had been epitomized in Malaysia government policies on environmental. The national policy towards environment have been established during 2002 aim to provide the policy framework for promoting the coordination of environmental management strategy especially towards CO_2 emission.

In fact, the policies that have been implemented are not effective enough to be truly sustainable to related with the aspect especially air pollution although some of the researchers had conducted the studies in Malaysia, so, to ensure the problems of CO_2 emission are not dealt with fragmented manner when the situation arises. Malaysia are still struggling to balance both economic development and environmental quality at which both are correlated. The existing policies are still unable to fully solve the problem of continuity of increasing in CO_2 emission in future rather than majority are focus on Malaysia digital economic development. It is useless to talk on eliminating the CO_2 emission pollution in Malaysia without seriously taking into accounts of its adverse effects on the general development strategies.

There are four research questions require to deal with the study of macroeconomics determinants of CO_2 emission in Malaysia as following;

I. Which of the macroeconomics variables is the most dominant contribute to CO_2 emission in Malaysia?

II. Which of the macroeconomics variables is the less dominant contribute to CO_2 emission in Malaysia?

III. Are there a short-run relationship between macroeconomics variables and CO_2 emission?

IV. Are there a long-run relationship between macroeconomics variables and CO_2 emission?

1.5 Objective of Study

1.5.1 General Objective

The general objective of this study is to investigates the relationship between macroeconomics variables and CO_2 emissions.

1.5.2 Specific Objective

The specific objectives are defined as follow:

I. To examine the relationship between macroeconomics variables and CO_2 emissions in long run for Malaysia.

II. To examine the relationship between macroeconomics variables and CO_2 emissions in short run for Malaysia.

III. To identify the exogenous macroeconomics variables that contribute to CO_2 emissions.

IV. To identify the endogenous macroeconomics variables that contribute to CO_2 emissions.

1.6 Significant of Study

This study conducted is to provide information and solutions recommendation to policy makers, researchers as well as society. The reason is because there is not much study of this topic conducted in Malaysia but for other country, regions and worldwide which touched on the effects of macroeconomics variables and CO_2 emissions.

However, the goal of this study is to aim to make a valuable contribution in the area of study that related to the CO_2 emissions and macroeconomics variables in Malaysia. In this respect, the study conducted is expected to be interest for Malaysian researchers and foreign researchers as their guidelines of research. Moreover, the most important is that the implications of the empirical work will be useful for policy makers in reducing CO_2 emissions and the society knowledge.

The contribution of this study will help in identify and implement the most effective policies or solutions in reducing CO_2 emissions for short-run and long-run impact in Malaysia. The finding and recommendation of this study is expected able to rebalance the economic development with environmental quality by implementing the particular suitable and effective policies. As mentioned in National Budget 2020, Malaysia is focus on and moving towards digital economy development, the policy makers should take more serious looks and actions towards the reduction of CO_2 emissions by develop, establish and implement the suitable and effective policies for short-run and long-run economic development because the development might worsen environmental degradation and have to be balance with environmental quality which currently struggled by Malaysia. Therefore, the finding of this study will recommend suitable and effective policies to Malaysia government agencies to implement and meet the sufficient CO_2 emissions reduction.

Next, to slow down and reduce the CO_2 emissions of Malaysia in future, this study is expected to improve the environmental knowledge sharing. The information and finding of this study are useful for society to become more aware on effect of air pollution on environment, economic and human health in Malaysia. With the power of the information technology such as social media and other online platform able to share the information widely across the regions with only lower costs involved.

As mentioned in problem statement of this study, the energy consumption also one of the major contributors of CO_2 emissions in Malaysia throughout many years. The study also might suggest to environmentalist as well as agricultural to shift the consumption of non-renewable resource to nuclear or renewable resource in energy production. By implementing this policy, the expected result will be decreasing in the long-run impact towards CO_2 emissions in Malaysia.

Since the problem of CO_2 emissions increasing throughout the years, therefore, this study will examine the relationship of macroeconomics variables and CO_2 emissions as well as investigates the dominant surveyed macroeconomic variables that contribute to CO_2 emissions in Malaysia.

1.7 Organization of Study

The study pay attention on the relationship between CO_2 emissions, GDP per capita, FDI, population, industrial structure and electricity production from oil, gases and coal source in Malaysia from 1980 until 2018.

The study is organized as following: In chapter two will reviews the related previous study on CO_2 emissions that have been done by many researchers. Next, in chapter two will divide into four sections that involve theoretical framework, empirical finding, literature gap and summary of previous studies. In the chapter three will discuss on the time series data and methods that need to use as well as expected sign of the survey macroeconomics variables in this study. Chapter four will analyses and interprets the empirical results. Finally, in chapter five will concludes the overall finding and provides the policy recommendation.

CHAPTER TWO

LITERATURE REVIEWS

2.1 Introduction

Basically, many of researchers believed that CO_2 emissions is affected by fundamental of macroeconomics variables. There several studies conducted by various researchers on the relationship between CO_2 emissions and macroeconomics factors in many countries and regions such as Africa, China, Indonesia, Malaysia, Azerbaijan, ASEAN and OECD countries.

Balogh and Jambor (2017) mentioned that economic development is a major factor related to CO_2 emissions. The more economic development will increase the energy consumption and led to more environmental pollution. Certain developing countries are just started to implement green technology policy for the purpose of reducing the excessive CO_2 emissions. There also some developing countries are still practicing traditional way of production that contributed to higher CO_2 emissions just as Indonesian agriculture are still practicing open burning of palm field to make a land clearance and replanting new baby trees. However, at the developed countries be more efficient in energy terms that contribute to low CO_2 emissions. Certain countries using energy will produce higher CO_2 emissions and certain countries using energy able to contribute lesser CO_2 emissions. Thus, this nexus has majorly discussed and tested in literature by using the different variables.

In this chapter two, it has split into six sections. Section 2.2 will be discussed on theoretical framework of this study. In Section 2.3 will discusses on empirical finding. However, in Section 2.4 will mentioned on literature gap and Section 2.5 reviews on concluding remark of chapter 2.

2.2 Theoretical Framework

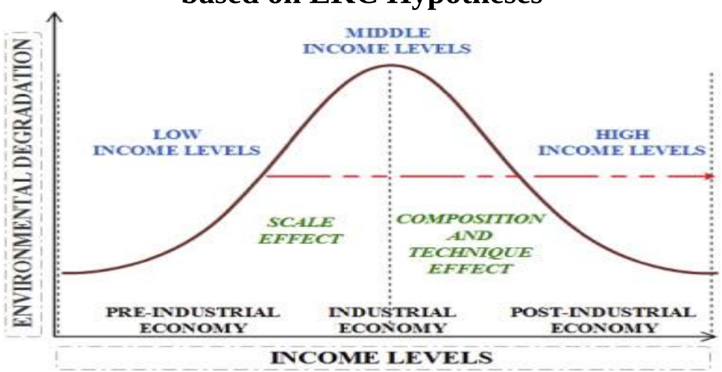
According to previous study, the relationship between GDP per capita, FDI, population, industrial value added and electricity production from oil, gases and coal source can be identified as following;

2.2.1 Income Per Capita

Many of the researcher hypothesize that increase in income level will cause the environmental degradation. The results will be different among the researchers that conduct the study in CO_2 emissions.

According to Beckerman (1992), actually in the real situation is that when the higher the income level, it would reduce environmental degradation and Bhagawati (1993) states that the economic growth will be precondition for environment improvement. In the short run, increase in income per capita will contribute more CO_2 emissions which cause environmental degradation, but when it reached turning point, the income per capita will keep on increasing while reducing CO_2 emissions. This also have been explained in EKC by Kuznet (1995).

Figure 2. 1: Relationship between income level and environmental degradation based on EKC Hypotheses



In the long run, income will grow higher that could make people better-off of living. People with higher income per capita achieved higher standard of living and with the existence of their knowledge on sustaining environment will be more responsible towards good quality of environment they lived surrounding. They also will demand for better environmental by convinces the structural changes in economy for the purpose to reduce the problem of environmental degradations. Roca (2003) states that at certain point of income level, the people willingness-to-pay to clean the environment will rises and become greater than proportion of income. This explain that people will go through defensive expenditures, donations to environmental organizations or choice towards less environmental damaging products and services. Therefore, the rich people will buy more luxury goods to value the clean and perverse the environmental.

According to Shafik and Bandyopadhyay (1992), the results of their theoretical underpinnings had suggested a non-linear relationship between environmental degradation and income. However, Ito (2017) and Mitic et al. (2017) state that increase in income level will increase the CO_2 emissions. Different consumers with higher income level will have different attitude and knowledge on environmental. Certain consumers with greater incomes level do not have the willingness to spend their money on green or environmental-friendly products. It created more pressure on environmental protection and regulations. Thus, for most of the situations, the CO_2 emissions will reduce with rising income level. This is because the national and local institutions reforms such as environmental legislation and the market based on reduction of environmental degradations.

2.2.2 Foreign Direct Investment (FDI)

According to Bakhsh et al. (2017), the result shows that FDI have positively related to CO_2 emissions. Shahbaz et al. (2015) and Kivyiro and Arminen(2014) founds that there is existence of bidirectional causality between CO_2 emissions and FDI in the long run. Besides that, Bae et al. (2017) states that FDI will increase CO_2 emissions in their investigation of determinants of CO_2 emissions that consist for 15 countries of Former Soviet region for the period of 2000 to 2011.

The pollution haven hypothesis (PHH) explained that FDI will more prefer host countries mainly in manufacturing and natural resource extraction industries to allocate productions due to less strictly environmental regulations or weak environmental enforcement laws or policies. In this case, the countries will more focus on FDI rather than care about environmental quality and CO_2 emissions produced will not be monitored strictly. When the environmental regulations or laws stricter than before, production within the CO_2 polluting industries will exit and enter new countries with low environmental standards. Thus, countries that have weak environmental regulations or laws will gain benefits from FDI due to the countries provide lower costs of production and comparative advantages in pollution intensive industries (OECD, 2017).

However, PHH claimed that FDI will cause more on CO_2 emissions. But this hypothesis will not always be applied because there is an opposite of it. According to Liang (2008), the results shows that the overall impact of FDI on the air pollution would be beneficial to the environmental. Shahbaz et al. (2018) also mention that FDI is one of the factors that beneficial for the environmental even though only for high income level countries. Besides that, Sung et al. (2018) depict that FDI have positive correlation with the improvement environmental quality.

The insurance sector, banking sector and investment sector will stimulate the business in society. The countries that working to accept and adopt green financing policy will against some of development project risks to avoid harm towards environment. For instance, the financing climate consider one of the components of green financing. This type of FDI transfer the financial flow to the projects related to environment and society by decreasing the level of CO_2 emissions. Lee (2013) states that the global development of financial market will rise the consistency of public information towards arrangement of renewable energy through external financing. Thus, the correlation between FDI and CO_2 emissions is bidirectional causality. It could positively and negatively impact on CO_2 emissions.

2.2.3 Population Growth

Previous of research conducted by researchers mostly are focusing on the economic growth, income per capita, energy consumption and industrialization as the determinants of CO_2 emissions. The only few numbers of studies that investigate the relationship between population growth and CO_2 emissions in Malaysia. The reasons due to the population in Malaysia are not as much as other country such as China and Indonesia which only 32.6 million of people (Department of Statistics Malaysia, 2019). Thus, in this study the factor of population will be include because it is one of the important determinants that will driven CO_2 emissions.

The previous studies that investigate on the relationship between population and CO_2 emissions shows there will be positive relationship which the population growth driven the CO_2 emissions into the atmosphere. According to Wang et al. (2013), they use STRIPAT model to examine the impacts of population and other factors on CO_2 emissions which the results indicates population is the most important factor influence the CO_2 emissions in China. Besides that, the study conducted by Ohlan (2015) in India shows the results that population density exerted as great positively influences on CO_2 emissions, and same reasons that as Wang et al. (2013) which it is main factor that affect in CO_2 emissions changes. Hang & Sheng (2011) derives that the population will boost the CO_2 emissions. This most of the researchers prove that population is an important factor cause higher CO_2 emissions in the country.

The CO_2 emissions will lead to global warming due to increase in the population and cause higher production and consumption activities (Bongaarts, 1992). The human daily activities such as deforestation to open new land for construction and development, burning fossil fuels to produce energy, use of fertilizer either chemical or organic and production of chlorofluoro-carbons (CFCs) gases will produce large amount of greenhouse gases emission into the atmosphere. Increase in the activity of deforestation causes less trees able to absorb the CO_2 gases produce by human and it will remain in the atmosphere. The rise of the atmospheric concentrations cause from CO_2 emissions will be determined by the complex way that the oceans and land will absorb the CO_2 emissions by chemical reactions. Thus, the increase in the populations will lead to high level of greenhouse gases that lead to complex climatic responses which is increase in the temperatures.

2.2.4 Electricity Production from Oil, Gases and Coal Source

Various studies from different countries mentioned that electricity and heat production is one of the main key sources of contribution to the CO_2 emissions. The contain to empirical studies examined the relationships between electricity production and CO_2 emissions.

According to Ahmad et al. (2016), their result depicts there is a long run cointegration relationship between the energy consumption and CO_2 emissions, they had a found positive nexus between the energy and CO_2 emissions. However, study on relationship among CO_2 emissions, electricity consumption, economic growth and financial development had conducted by Salahuddin et al. (2015). The outcomes depicted that both of electricity consumption and economic growth are positively affect CO_2 emissions while the financial development negatively affect CO_2 emissions. They also found there is a causality relationship to CO_2 emissions by electricity and bidirectional causality among growth and CO_2 emissions.

The electricity production lead to CO_2 emissions because the people demand the electricity is increasing together with increase in population and economic growth in the country. The electricity production was using different natural and raw resources such as coal, fossil fuels, oil, natural gases and nuclear power. By using these natural raw resources that classified under the resources will be depleted, throughout the process to produce electricity supply will emit CO_2 emissions into the atmosphere which cause the temperature to raise rapidly (Zhang and Cheng, 2009).

However, some of the studies had shown different results of the relationship between electricity and CO_2 emissions. The results of previous studies show the electricity will negative influence the CO_2 emissions which could reduce environmental degradation. Mezghani and Haddad (2017) states that with huge electricity consumption volatility might have negative impacts towards CO_2 emissions and oil GDP. According to Adom et al. (2012), the negative impact from electricity production on CO_2 emissions happen when industrial structure taken as important determinant of CO_2 emissions. The shifting in the industrial structure from energy-intensive such as coil, fossil fuel, natural gases and other scarcity resources to non-energy-intensive sectors such as water-powered electricity, hydrogen technology, wind-powered technology and other renewable resources help in reducing the CO_2 emissions at an affordable economic cost.

2.2.5 Industrial Structure

Many of the previous literature had mentioned that the industrial structure is an important factor that cause CO_2 emissions. According to Zhu et al. (2014), changing in the industrial structure from non-renewable energy to renewable energy sectors will meet the CO_2 emissions reduction and at the affordable economics cost. Tian et al. (2014) also states that adjustment of industrial structure from high to low-carbon industries and services will lead to CO_2 emissions reduction.

According to Li et al. (2017), there are three way the changing of industrial structure can ease the CO_2 emissions reduction. Firstly, the rationalization of the industrial structures. They state that the good allocation and flows of the resources between the among the industries lead to regional input-output efficiencies which able to meet CO_2 emissions reduction. Next, shifting of industrial structure to service sector also can decrease the CO_2 emissions. This is because the service sector only produces low energy consumption and CO_2 emissions due to the sector is important in playing as a role of reducing environmental degradation. Finally, the evolution of industrial structure from low-tech to high-tech industries also can meet CO_2 emissions reduction. The industrial structure practicing high-tech policies have features of knowledge-intensive towards reducing the number of highly polluting industries and energy-base industries. The high-tech industries can lower the CO_2 emissions through conducting a research which the development of environmental or greener technologies and implementation of cleaner production equipment. Therefore, shifting of the industrial structure able to reduce the CO_2 emissions.

However, there some researchers have the contrast finding on the industrial structures and CO_2 emissions. According to Geng et al. (2013) and Zhang and Da (2015), both of the studies argue that industrial structural adjustments would lead to increase in CO_2 emissions. The reason of increasing in CO_2 emissions due to the dominant positions of the high-carbon industries in the industrials revolutions. Hence, the finding is differ among literature due to the different regions, different structure practiced and different methods.

2.3 Empirical Finding

Based on previous study, Lantz and Feng (2006) investigate the driving factors such as GDP per capita, population and technology towards CO_2 emissions in Canada by using province-level panel data from 1970 until 2000. The result shows that GDP per capita, population and technology reveal insignificant inverted U-shape EKC and U-shaped EKC relationship with CO_2 emissions respectively. Their study had rejects the EKC hypothesis. Besides that, the changes in GDP per capita will not significantly influence CO_2 emissions. Their finding also depicts that increase in wealth may not played role in recent efforts to reduce CO_2 emissions by using Kyoto Protocol.

Ang (2008) examined the long run equilibrium relationships among energy consumption, CO_2 emission and real GDP per capita for annual time-series from 1971 to 1999 in Malaysia. The result shows that there is a long run equilibrium relationship between the inspected variables. The finding also depicts that CO_2 emission and energy consumption were positively correlated with real GDP per capita in long run and short run. Similar to Alam et al. (2012), they had investigated the long run equilibrium relationships between CO_2 emission, energy consumption and real GDP for annual time series data from 1972 to 2006 in Bangladesh. By using the ARDL approach in their study, the result shows that there is a positive long run equilibrium relationship among examined variables. Besides that, Halicioglu (2009) conducted a research on long run equilibrium relationships among CO_2 emission, energy consumption and real GDP and FDI for the annual time series of 1960 to 2005 in Turkey. By using the method of ARDL, the finding shows that there is a long run equilibrium relationship between the dependent and independent variables. In addition, the results of the study also derived that EKC hypothesis are not exist for CO_2 emission.

Ang (2009) had conducted study to analysed China CO_2 emissions and energy consumption for data of 1953 to 2006. The result obtained shows that the greater the energy consumption used, higher level of income and greater trade openness would contribute to increase in CO_2 emissions. Besides that, Hwang and Yoo (2014) had examine the relationship between CO_2 emissions and energy consumption in Indonesia for the annual time series data of 1953 to 2006. The result was similar to Ang (2009) which explain that rising in energy consumption directly influences CO_2 emissions. They also found that there is a bidirectional causality between energy consumption and CO_2 emissions.

Lim et al. (2014) has investigate the oil consumption, carbon dioxide emissions and growth in Philippines for the time series data of 1965 to 2012. The result depicts that there is a negative correlation among CO_2 emissions and economic growth in the long run. The same finding by Ghosh et al (2014) shows that there is a negative correlation between CO_2 emission and economic growth in Bangladesh. Despite from that, Hammami and Saidi (2014) and Kais and Mbarek (2014) had investigate interaction between energy consumption, CO_2 emissions, and economic growth in Algeria and Tunisia for panel data of 1990 to 2012. The GMM model used in their study shows that CO_2 emissions was negatively CO_2 emissions correlated to economic growth.

Arvin et al. (2015) have conducted a study on G-20 countries which consist of 19 countries and European Union. They investigate the relationship and causality among the macroeconomics variables such GDP and CO_2 emission for two types of countries in G-20 which is developing countries and developed countries. By using Panel Var approach to test the variable in long run, their result shows there are unidirectional causality from GDP to CO_2 emission in G-20 developing countries and unidirectional causality from CO_2 emission and GDP in G-20 developed countries. For the whole G-20 countries, there is unidirectional causality from GDP to CO_2 emission in the long run. Apart from that, Alshehry and Belloumi (2015) had investigate the causality between energy consumption, economic growth and CO_2 emission in Saudi Arabia which is one of G-20 for the time period from 1980 to 2011. By using VECM granger causality approach, the results show there is unidirectional causality from energy consumption to economic growth and CO_2 emission while there is bidirectional causality between CO_2 emission and economic growth for long run. Besides from that, they also found unidirectional causality from CO_2 emission to energy consumption and economic growth for short run.

Besides that, Nain et al. (2016) have determined the relationship between CO_2 emission and macroeconomic variables for the time series data in India from 1971 to 2011. Their study used the aggregated and disaggregated of energy consumption to examine the CO_2 emission function and the macroeconomics variables involve both economic growth and energy consumption variables. In their study, the result obtained shows the economic growth and energy consumption causes increasing in CO_2 emission. However, Ahmad et al. (2016) using the same method to examine the relationship among energy consumption, economic growth and CO_2 emission with annual time series of 43 years which from 1971 to 2014 for both of aggregated and disaggregated levels in India. The similar result produced which validated the long run relationship between variables underlying variables.

One of the studies that explores the primary influencing factors of CO_2 emission in China was conducted by Wang & Lin (2016) for period of 34 years which from 1980 to 2014. The identified factors of CO_2 emission include GDP per capita, urbanization and energy consumption that will influence the CO_2 emission. However, the result shows that the shock of GDP per capita, energy structure and urbanization have positive impacts towards CO_2 emission while the shock of energy intensity has negative effect in long run. Moreover, GDP per capita is one of the most influence factors that contribute to CO_2 emission in China's commercial sector and with the sequences from urbanization, energy structure and energy intensity in that order.

Zhou et al. (2018) have examines the impacts of socioeconomics variables such as, FDI, economic growth, urbanization, economic structure, energy consumption structure and total trade on CO_2 emission in China for the time series of 1980 to 2014. Firstly, they used Johansen cointegration approach to examines the cointegration relationship between variables and the result shows that the impact of all socioeconomics variables on CO_2 emission are significant in short run. The results obtained from Granger Causality approach have shows there is bidirectional causal relationship between CO_2 emission and energy consumption structure as well as between CO_2 emission and economic structure. There is unidirectional causal relationship between from CO_2 emission to GDP, urbanization to CO_2 emission and CO_2 emission to trade. There is no relationship identified between CO_2 emission and FDI. Lastly, the result from Impulse response indicates that economic structure and energy consumption structure are projected to have strong and significant forecast effects on CO_2 emission continuously in the future. However, the impact of FDI, total trade and urbanization are less importance in forescast. Hence, the GDP is one of the dominant factors that significantly contribute to CO_2 emission.

Chakamera and Algidede (2018) had investigates correlation electricity quality development and CO_2 emissions in 18 Sub Saharan African (SSA) countries for data from 1990 to 2013. Their finding shows that there is negative growth in electricity quality development that will influences CO_2 emissions to increase. As a result, the CO_2 emissions cause by electricity and heat production will lower the growth effects from electricity consumption or stock and quality. Hence, the electricity produced from non-renewable energy sources which mainly from coal is dominant in this region while the percentage of renewable sources is still insignificant.

In additions, Sasana and Putri (2018) study the relationship between energy consumption and CO_2 emissions in Indonesia for time series data from 1990 to 2014. Firstly, the result from OLS regression shows that population growth variable has positively and significantly affect CO_2 emissions. Secondly, the results of their study also show that the variable of energy consumption based on non-renewable fossil energy has positively but not significantly influence CO_2 emissions. Finally, the result also shows that the energy consumption of renewable energy has negative and significant effect on Indonesia's CO_2 emissions. Hence, higher consumption in non-renewable energy such as fossil will contribute to greater concentration of CO_2 emissions. In contrast, higher consumption in renewable energy will contribute to lower concentration of CO_2 emissions.

Fatima et al. (2018) studied the relationship among industrial growth, CO_2 emission and energy consumption at aggregate and disaggregate levels in China for the period of 1984 to 2015 times series data. In this study, they diverse the function of CO_2 emission by adding different type of sources of energy in the industrial sector of China such as oil, coil and natural gases. The results from the ARDL and combined cointegration had confirmed that there is existence of cointegration relationship among CO_2 emission, industrial growth and four sources of energy consumption.

Moreover, Alshubiri and Elheddad (2018) had study the relationship among economic growth, foreign finance, and CO_2 emissions to investigate is there an EKC exists in 32 selected OECD countries. They used panel data which consist of 32 countries and with period from 1990 to 2015 and ensured 27 observations for each country. In their study, they used panel OLS estimator through Finite Element (FE) model and solved the problem of endogeneity using Generealized method of moments (GMM), IV-FE estimators and diagnostic tests. The results depict that FF-environmental degradation relationship achieved a sharp like inverted U EKC while the relationship between economic growth and CO_2 emissions is N-Shaped.

Balsalobre-Lorente et al. (2018) have proven EKC hypothesis existence between GDP growth and CO_2 emission in five Europe Union countries for period of 31 years which from 1985 until 2016. The partial least squared method had been used to examines the linear relationship between CO_2 emission (dependent variables) and GDP growth (independent variables). The result depicts there is an N-shape EKC relationship between the economic growth and CO_2 emissions.

2.4 Literature Gap

The study of economic growth and CO_2 emission had been conducted by Saboori et al. (2012) in Malaysia. The similarity of the study is that they used one of the important CO_2 emission driven factor which is income per capita and conducted for Malaysia country. Some of the researchers also used the Granger causality to test the causal relationship between the CO_2 emission and income as well as with other independent variables. However, the gap of their study is that they do not include the additional variables in their study or other words is single linear regression. The study should use multiple linear regression at which there is others major factor that contribute to CO_2 emission such as industrial structure, FDI, and population in Malaysia. However, their finding does not really provide a lot of information on the observed invented U-shape relationship between the environmental degradation and income in Malaysia. Thus, this study will use multiple regression which the series involved are GDP per capita, electricity production, FDI, industrial structure and population in Malaysia. The study also will identify the sequence of domination of the macroeconomics variables that contributed to CO_2 emission.

However, Chin et al. (2018) study on the determinants of CO_2 emission in Malaysia with a new aspect which almost similar with this study. The similarity is both of the studies are examines the CO_2 emission with it determinant which involve GDP per capita. The study also conducted at the same country which is Malaysia. In Chin et al. (2018) study, the surveyed variables include real GDP per capita, foreign direct investment outflow from China and value of intra-industry trade in manufacturing. The gap from this study is they did not use the big sample time series data but use small sample size data which only 18 years of observation from 1997 to

2014. The disadvantage of using small sample size is it will affect the reliability of the study results due to high variability. Thus, small sample size might lead to bias results. Their study also just focusing on the China's FDI outflow to Malaysia which does not involve other FDI from other country. Hence, this study was to identify the macroeconomics variables including total FDI inflow of Malaysia and identify the most dominant to less dominant variables that contribute to CO_2 emission which does not identified in their study.

Rambeli et al. (2019) had conducted the study on the interaction between energy consumption and CO_2 emission in Malaysia. Under their research, the survey variables involve CO_2 emission, real GDP per capita, total primary energy consumption, total employment and index of industrial production for time series of 1986 to 2018. There are of study are focusing on energy consumption which there also other variables such as FDI and population does not include. Other than that, there is no study conducted on the energy production that influence the CO_2 emission in Malaysia at which it also contributed to CO_2 emission. Although their finding had identified that energy consumption is the major factor contribute to CO_2 emission in Malaysia, but the results does not clarify on the sequence of the variables that contribute to CO_2 emission. Therefore, the purpose of this study is to determine the exogenous and endogenous of macroeconomics that involve population and FDI which contribute to higher CO_2 emission in Malaysia.

As summarization, the similarity of the study with other studies is the some of the study used one of the important and major factors that contribute to CO_2 emission which is income per capita and conducted in Malaysia. However, the gap of studies is most of the researchers does not clarify on the sequence of domination of the variables that interact with the CO_2 emission in Malaysia. It is important to identify the domination due to different variables will act differently and variety of policies can be implements. There also no study involved total population of Malaysia that contributed to CO_2 emission instead of focusing on urban population. Same goes to industrial structure in Malaysia, some of the study are only focus on the specified industrial sector such as manufacturing and not the changing of the industrial structure throughout the years in Malaysia. Therefore, the aim of this study is to use their missing peace in this study and investigate the relationship and sequence of domination of macroeconomics variables.

2.5 Concluding Remark

Based on the previous studies, the CO_2 emission and its determinants had been studied and investigates by many researchers. The studies mostly conducted in developing country that Asian countries ASEAN regions and other regions.

As a summarize, Beckerman (1992) states that increase in income level will reduce the environmental degradation while Bhagawati (1993) indicates that in the short run the increase in income per capita will lead to higher CO_2 emission. After reaching the turning point, increase on income per capita will reduce the CO_2 emission. This shows that the behaviour is based on the inverse U-shaper EKC.

For the series of foreign direct investment, according to Bakhsh et al. (2017) and Bae et al. (2017), their founding provided similar results at which the FDI is positively related to CO_2 emission. In contrast, Shahbaz et al. (2018) explained that FDI is one of the important factors for environment because it is beneficial to environment quality.

According to Wang et al. (2013) conducted study in China and Ohlan (2015) in India, their results shows that the population density behave as great influences on CO_2 emission. The reason behind was because increase in population will encourage more human activities such as deforestation, burning fossil fuel and produce chlorofluoro-carbon gases into atmosphere.

Next, Adom et al. (2012) mentioned that the electricity production have negative impacts on CO_2 emission when the industrial structure taken as important determinant of CO_2 emissions. However, Ahmad et al. (2016) states that there is positive relationship between energy consumption and CO_2 emission.

Table 2. 1 Summary of Literature Review

Author (s)	Data	Methodology	Finding(s)
Fatima, Xia and Ahad (2018)	• Data from this study have obtain from 3 sources ✓ National Bureau of Statistics China (2016) ✓ China Energy Statistical Yearbook (2015) ✓ World Development Indicator (2015) • Variables: ✓ Industrial growth ✓ CO_2 emissions and energy consumption at aggregate and disaggregate levels. • Country: China • Period: 1984 to 2015 • This time period had been selected due to non-availability of data. • Type of data: Time series data	• Unit root test • ARDL bound testing approach • Autoregressive distributed lag bound testing approach • Bayer and Hanck combined cointegration • VECM Granger causality	• Traditional unit root test explained problem of unit root at level but at first different, the series become stationary. • There is presence of long-run relationship among CO_2 emission, industrial growth and various types of energy used in industrial sector. • The long run coefficient of natural gas is lower than total energy, crude oil and coal consumption which shoews that natural gas is less polluting than other sources. • Strong bidirectional causality relationship among CO_2 emission and industrial growth, between CO_2 emission and different type of energy source and between industrial growth and different type of energy consumption. • The China government have to subsidize natural gas consumption as one of the economic incentives to market gas utilization in china industrial sector which under the climate change policies and regulations.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Mugableh (2013)	• Sources: World's Bank development indicator • Variables: ✓ CO_2 emissions in metric tonnes ✓ GDP per capita in thousands ringgit Malaysia ✓ Energy consumption in kilograms of oil • Country: Malaysia • Period: 1971 to 2012 • Long span of annual time series data	• Unit root test ✓ Kwiatkowski, Phillips, Schmidt and shin (KPSS) test • ARDL Approach	• The studied variables are stationary at *I(1)*. The F-test shows the variables in all models are co-intergrated. • The study results suggest that Malaysia is a country depending on energy consumption. When energy consumption is positively related GDP in both long run and short run. Which means the higher the GDP contribute to higher CO_2 emission. • There is an inexistence of EKC hypothesis Malaysia economy.
Mikayilov et al. (2018)	• Source: World bank Development Indicators Database • Variables: ✓ CO_2 emissions ✓ GDP per capita ✓ Population • Country: Azerbaijan • Period: 1992 to 2013	• Unit root tests • Cointegration methods	• The relationship between CO_2 emissions and income will be monotonically increasing. • The economic growth has positive and statistically significant influence CO_2 emissions in long run. • The country has potential to materialize economic development by using energy conservative measures without leading into higher CO_2 emissions. • By improving the energy efficiency is suitable policy which can be obtain by increase optimal infrastructure investment and employing energy conservative policies to avoid unnecessary energy used.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Wang and Lin (2016)	• The data are obtained from 3 different sources: ✓ China Statistical Yearbook ✓ CEIC ✓ China Energy Statistical Yearbook • Variables: ✓ CO_2 emission of commercial sector ✓ GDP per capita ✓ Energy intensity ✓ Urbanization rate ✓ Terminal energy structure. • Country: China • Period: 1980 to 2014	• VAR model construction • Impulse-response functions • Variance decomposition	• The shocks of GDP per capita, urbanization and energy structure are positively contributed to CO_2 emission and shock of energy intensity are negatively influenced in long run. • GDP per capita is first driving factor of CO_2 emission followed by urbanization, energy structure and energy intensity in China. • The China need to promote development such as using energy saving technologies of other commercial industries to help in improving energy efficiency of entire commercial sector because most of the them are still individual workshops with low energy efficiency, combination and reorganization. • The central heat system should introduce in China to reduce usage of coal in wholesales & retail trader industry and hotel & catering services industry.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Leal, Marques and Fuinhas (2017)	• Variables: ✓ Coal and oil turn into percentages of primary energy consumption ✓ CO_2 emission turns into CO_2 intensity for the purpose in lowering correlation among variables. • Country: Australia • Period: 1965 to 2015	• Traditional unit root test: ✓ ADF test ✓ PP test ✓ KPSS test • Autoregressive distributed lag ✓ ARDL model	• All of the variables are stationary in first differences, *I(1)*. • The renewable energy sources positively influence fossil fuel consumption which renewable energy sources giving incentive by oil consumption. Based on environmental perception, CO_2 intensity raise with increase in fossil fuel consumption which the problem can reduce by use more in renewable energy source consumption. • Increase in economic growth lead to increase in CO_2 intensity, while CO_2 intensity negatively influence GDP. Which means in Australia, there is existence trade-off between economic development and environmental quality.
Alshehry and Belloumi (2015)	• Variables: ✓ Energy consumption ✓ Economic growth ✓ CO_2 emission • Country: Saudi Arabia • Period: 1980 to 2011 • Time series data	• VECM Granger Causality test	• In long run, there is unidirectional causality from energy consumption to economic growth and bidirectional causality between CO_2 emission and economic growth. • In short run, there is unidirectional causality from CO_2 emission to energy consumption and CO_2 emission to economic output.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Arvin et al. (2015)	• Variables: ✓ GDP ✓ CO_2 emission • Regions: G-20 countries • Period: 1961 to 2012 • Panel data	• Panel VAR test	• In developing countries of G-20, unidirectional causality from GDP to CO_2 emission for long run. • In developed countries of G-20, unidirectional causality from CO_2 emission to GDP in long run. • In all countries of G-20, unidirectional causality from GDP to CO_2 emission in long run.
Bento and Moreira (2017)	• Sources: US Bureau of Economic Analysis (BEA) and World Bank's World Development Indicators • Dependent Variable: ✓ Environmental Pollution • Independent Variables: ✓ Foreign Capital ✓ Subsidiary Profitability ✓ Value added per employee • Countries: 67 developing countries and 34 developed countries • Period: 2004 to 2014	• Dynamic Panel Method GMM • Two-steo version of difference GMM estimator	• R&D intensity balances the relationship between FDI and environmental pollution for both developing and developed countries in the way of environmental pollution decrease. The developing countries able to obtain technology spillovers through FDI and further explain the existence of PH. • There is more progressively environmental-friendly perspective will be deployed by MNEs as developing countries are incorporating more stringent environmental policies.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Zhou et al. (2017)	• The data obtained from 2 sources: ✓ China Statistical Yearbook ✓ China Energy Statistical Yearbook • Surveyed variables: ✓ CO_2 emissions ✓ Urbanization rate ✓ GDP per capita ✓ Economic structure ✓ Energy consumption structure ✓ Total trade and foreign direct investment (FDI). • Country: China • Period: 1980 to 2014 • Annual time series data	• Descriptive analysis and correlation • Unit root test • Johansen Cointegration test • Estimation of VECM • Granger Causality tests • Impulsive analysis • Variance decomposition analysis	• The findings support the way of efforts towards acceleration of development of service in industry by specific governmental plans in raising added value of China's service sector and advancing amount of contribution to GDP. • Secondly, China should increase development of natural gas and other clean sources to optimize energy consumption structure, reduce the proportion of energy consumption that contribute to high CO_2 emissions such as coal. • Thirdly, the migration millions of people from rural to urban areas by processing of urbanization contribute to higher CO_2 emissions levels. • Finally, China government should create an investment-friendly environmental in the purpose to attract more FDI investment. • The efforts to balance domestic demand and foreign trade need to pursued while depicting restraint export of energy-intensive and high-emission products.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Balogh and Jambor (2017)	• Sources: World Bank (2017) World Development Indicator's database • Variables: ✓ CO_2 emission per capita ✓ GDP per capita ✓ Squared GDP per capita ✓ Electric production from nuclear source ✓ Electric production from coal, renewable ✓ Renewable electricity output ✓ Agricultural value added per hectare ✓ Agricultural value added per worker ✓ FDI, net inflows ✓ International tourism arrivals ✓ Total trade ✓ Industrial structure, industrial value added • Country: 168 countries from 6 continents globally • Period: 1990 to 2013 • Panel data analysis	• Wooldridge (2002) test • Linear dynamic panel-data models • Standard GMM system estimator • Arrellano and Bond (xtabond) model test	• The nuclear energy and renewable energy production played important role in environmental while energy production from coal will contribute to pollution. • The size of industrials in total economy significantly contribute to environmental pollution. • When agricultural development reduces, impacts of agricultural land productivity contribute to environmental pollutions at global level. • The extension of international tourism and trade contribute to environmental degradation by increase CO_2 emissions to atmosphere. • The financial development reduces CO_2 emissions. • Decision makers should focus on nuclear or renewable sources to reduce global air pollution and achieve requirements of Paris Agreement.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Chakamera and Alagidede (2018)	• Sources: World Bank Group from World Development Indicator (WDI) • Variables: ✓ Electric power consumption and electric power transmission and distribution losses ✓ CO_2 emission from heat and electric production ✓ GDP per capita ✓ Domestic credit to private sector ✓ Inflation ✓ Consumer prices ✓ Trade ✓ Urban population • Countries: 18 of Sub Saharan Africa (SSA) countries • Period: 1990 to 2013	• Cross-section dependence (CD) test • Pesaran CIPS unit root test • Two Stage Least Squares (2SLS)	• Electricity consumption have positive growth that contribute in SSA and contribution declines when effects of CO_2 emission is included. • Negative growth in electricity quality developments effects will cause more CO_2 emission. • The electricity power generation from renewable sources are still very low in SSA which it should be major concern for respective government and effective policies need to introduce to promote renewable energy production.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Alshubiri and Mohamed Elheddad (2018)	• Variables: ✓ Economic growth ✓ CO_2 emission ✓ FDI • Region: Organization for Economic Co-operation and Development (OECD) Countries • Period: 1990 to 2015 • Panel Data	• OLS estimator through fixed-effects control • Generalized method of moments (GMM) • Diagnostic Tests	• Foreign finance and quality of environmental have inverted U-shaped association. Three of prxies' foreign assets and remittance in first stages significantly cause CO_2 emission. However, after threshold point reached, the proxies become environmental-friendly through their support to decreasing CO_2 emission. • Non-linear relationship means the foreign investment in OECD nations increase important as proxy foreign finance has greater environmental quality than foreign assets. • The remittances received linked to greatest polluted levels until threshold point reach which at the point it helps to started to reduce CO_2 emission.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Cederborg and Snöbohm (2016)	• Source: World Bank Database • Variables: ✓ CO_2 emission ✓ GDP per capita ✓ Squared GDP per capita ✓ Renewable Electricity ✓ Electricity Coal ✓ Livestock Production • Countries: Industrial countries with Human Development Index (HDI) more than 0.5 • Period: 2012	• Regression Model • Variance Inflation Factors (VIF) test	• The interaction between GDP per capita and CO_2 emission per capita statistically supported at highest level of significant. The increase in GDP per capita lead to increase in level of CO_2 emission. • Decrease in CO_2 emission is not strong enough to applied for EKC hypothesis on its own reality.
Sasana and Putri (2018)	• Dependent Variable: ✓ CO_2 emission • Independent Variables; ✓ Population growth ✓ Fossil energy consumption ✓ Share of renewable energy consumption • Country: Indonesia • Period: 1990 to 2014 • Time series secondary data	• Ordinary Least Square (OLS) regression analysis technique • Logarithm Natural Equation (Ln) model	• The greater the consumption of energy in Indonesia contribute to higher CO_2 emissions. The CO_2 emissions is expected raising continuously with increase in industrialization rate for many developed countries such as Indonesia. • The renewable energy consumption negatively influenced amount of CO_2 emissions in Indonesia which in crease in energy consumption lead to reduce in CO_2 emissions. • The effect of fossil energy consumption towards amount of CO_2 emissions was positive but not significantly in Indonesia.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Lantz and Feng (2005)	• Sources: Stats Can (1970-1977), Stats Can (1978-2000), Stats Can (2003) and Environment Canada (2003) • Variables: ✓ CO_2 emissions ✓ GDP per capita ✓ Population density ✓ Technology • Countries/Region: Five Canadian Region ✓ Atlantic Canada ✓ Quebec ✓ Ontario ✓ Prairies ✓ British Columbia • Period: 1970 to 2000 • Panel data	• Augmented Dickey-Fuller test and Phillips-Perron Test • Standard F / Wald test statistic • Generalized least squares (GKS) econometric procedure • Durbin-Watson test	• The GDP per capita, population and technology shows insignificant for invested U-shaped and U-shaped relationship with CO_2 emissions respectively. • The finding rejects possibilities for using province-level data set in Canada and does not support Canada signing Kyoto Protocol due to income related. • The population growth increase in using of fossil fuel to support raising demands for goods and services. • Technological and economic structural changes to favour CO_2 emissions intensive production process for recent years.

Table 2.1 Summary of Literature Review (Continued)

Author (s)	Data	Methodology	Finding(s)
Pazienza (2019)	• Source: Statistical databases of various international organisations • Variables: ✓ CO_2 emissions ✓ Economic Growth ✓ FDI • Countries: 30 OECD countries • Period: 1989 to 2016 • Panel data econometric technique	• Model specification • Ordinary Least Squares (OLS) • Fixed Effects (FE) estimator • Random Effect (RE) estimator	• The promotion of free investment is necessary although insufficient to ensure the FDI exerts positive effects on environmental because of technology innovation implicitly living investment activities from more efficient allocation of resources and small negative impact on environmental. • Investment activities lead capital accumulation process which not accompanied by correct absorption of technology innovation. The Pigouvian taxation mechanism policy is needed to followed for internalisation of negative externalities.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study is aims to investigate the relationship and impacts between GDP per capita, FDI, electricity production, industrial structure and CO_2 emission in Malaysia. To achieve the objective of this study, the involved process include identifies variables, select timeframe, collect time series data, identify the methods and lastly test will be conducted. First, the empirical model of study will be discussed under Section 3.2. Secondly, to test the stationary of the time serires variables, the study will implement the unit root tests include Augmented Dickey-Fuller (ADF) Test, Phillips-Perron (PP) Test and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test and Johansen Cointegration test, Vector Error Correlation (VECM) granger causality test and VECM normalized equation will use to investigate the relationship and impact between the variables in term of long-run and short-run as well as variance decomposition to identify exogenous and endogenous variables. The methodology will further discuss in the Section 3.3. Lastly, the Section 3.4 will data description of definition and transformation of variables and time period.

3.2 Empirical Model

The empirical model will be express as the following;

$$LCO2_t = \alpha + b_{GDPPC}LGDPPC_t + b_{POP}LPOP_t + b_{IS}LIS_t + b_{FDI}LFDI_t + b_{EP}LEP_t + \varepsilon_t \quad (3.1)$$

Where $LCO2_t$ is the natural logarithm of CO_2 emission for period of *t*, α is the constant and *b* is the reaction of coefficient or parameters that measure the change towards dependent variables. The set of the macroeconomics factors show as following:

$LGDPPC_t$ denotes as Natural Logarithm of GDP Per Capita for period of *t*

$LPOP_t$ denotes as Natural Logarithm of Total Population for period of *t*

LIS_t denotes as Natural Logarithm of Industrial Structure for period of *t*

$LFDI_t$ denotes as Natural Logarithm of Foreign Direct Investment for period of *t*

LEP_t denotes as Natural Logarithm of Electricity Production from Oil, Gases and Coal Source for period of *t*

In the model (3.1) depicts the relationship between dependent variable which is logarithm of CO_2 emission with independent variables which are logarithm of GDP per capita, logarithm of FDI, logarithm of electricity production and logarithm of industrial structure in Malaysia.

3.3 Methodology

3.3.1 Unit Root Tests

The purpose of using the unit root tests is examine stationarity of the surveyed variables in the period properties and to identify the order of integration within the period observation. There are various type of unit root tests such as Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Kwiatkowski, Phillips, Schmidt & Shin (KPSS) test, Elliot, Rothenberg & Stock Point Optimal (ERS) test and Ng & Perron (NP) tests. Thus, only ADF test, PP test and KPSS test will be used in this study to get more accurate results.

3.3.1.1 Augmented Dickey-Fuller (ADF) Test

The ADF test will use to test the stationarity of all times series data. The first developer of ADF test was by both Dickey and Fuller (1981) for the purpose of testing stationary of properties of the variables. The example of ADF test model of unit root is shown as following;

$$\Delta LCO2_t = \mu + \delta LCO2_{t-1} + \sum_{i=1}^{k} \beta_i \, \Delta LCO2_{t-1} + e_t \qquad (3.2)$$

Where δ is the $\alpha - 1$, α is the coefficient of $LCO2_t$, $\Delta LCO2_t$ indicates as the first difference of $LCO2_t$, μ denotes as intercept, *k* represent the lag length of the variable, *t* represent the times series trend and e_t indicates as error term of period *t*. The model (3.2) is the ADF model contains of trend and intercept.

The null hypothesis and alternative hypothesis of ADF test shown as following:

$$H_0\colon \delta = 0$$

$$H_1\colon \delta < 0$$

The null hypothesis of ADF test mentions that there is existence of unit root and the series are non-stationary while against the alternative hypothesis states that there consist of no unit root and the series is stationary.

The *t*-statistic of ADF test will identify either the variables is stationary or non-stationary. However, the optimum lag length will obtain from the formula $4\left(\frac{n}{100}\right)^{\left(\frac{1}{4}\right)}$. The rejection rule is based on the critical value (CV) with 1%, 5% or 10% of significant level. When the *t*-statistic value is higher than critical value at significant level, the null hypothesis will be rejected and lead to result of variable contains no unit root as well as it is stationary. Whilst, when the *t*-statistic value is smaller than CV at significant level, do not reject the null hypothesis and lead to the result of variable contains unit root as well as non-stationary.

3.3.1.2 Phillips-Perron (PP) Test

The equation of PP test expressed as following:

$$\Delta y_t = \pi y_{t-1} + \beta_i D_{t-i} + e_t \tag{3.3}$$

Where e_t is integrate at level, I(0) with zero mean and the D_{t-i} as deterministic trend of component.

According to Shrestha and Bhatta (2017), PP test is more accurate then ADF test because it corrects the statistic that consists of autocorrelation and heteroskedasticity problems in the model.

Both hypotheses of PP test are similar to the ADF test;

$$H_0 \colon \beta = 1$$

$$H_1 \colon \beta < 1$$

The null hypothesis of PP test mentioned that the variable consists of unit root and the series considered as non-stationary. However, the alternative hypothesis states that the variable consist no unit root and the series considered as stationary.

To identify the stationarity of surveyed variables, t-statistic of PP test will be implemented. However, the bandwidth of PP test will be selected based on Newey-West criterion with Barlett Kernel Method. The rejection rule of PP test is based on the CV of 1%, 5% and 10% significant level. When the result of t-statistic of the PP test is higher than CV at significant level, reject the null hypothesis. Thus, there is the absent unit root in the variables and it is stationary. In contrast, when the t-statistic result is smaller than CV at significant level, do not reject the null hypothesis. Thus, the variable consists of unit root and it is non-stationary.

3.3.1.3 Kwiatkowski, Phillip, Schmidt and Shin (KPSS) Test

According to Shrestha and Bhatta (2018), the classical unit root tests sometimes can be not accurate and biased in accepting the null hypothesis. Therefore, KPSS test is developed to test the stationarity of the series. The KPSS test model will be express as following;

$$Y_t = X_t + \varepsilon_t, which\ the\ X_t = X_{t-1} + u_t \tag{3.4}$$

Based on model (3.4), the hypothesis is used to test for the u_t, Y_t is dependent variable with period of t and ε_t denotes as error term with period t.

The null hypothesis of KPSS test is an opposite of ADF test and PP test null hypothesis which it presented as following;

$$H_0: \sigma_\mu^2 = 0$$

$$H_1: \sigma_\mu^2 > 0$$

The null hypothesis depicts that the variables consist no unit root and become stationary. In contrast, the alternative hypothesis depicts that the variables consist of unit root and which the variables also are non-stationary.

However, the rejection rule will base on the KPSS *t*-statistic to determine the stationarity of variables. Next, the Newey-west criterion will be used to choose the bandwidth of the test based on the Bartlett Kernal method. Under the rejection rule, when the *t*-statistic is greater than the CV at significant level, the null hypothesis will be rejected. It shows that the variables consist of unit root and it is non-stationary. In contrast, when the *t*-statistic is smaller than CV at significant level, the null hypothesis will not be rejected. Hence, the variables consist no unit root and become stationary.

3.3.2 Autoregressive Distributed Lag Model (ARDL) Approach

Johansen Cointegration test only can be applied if all of the variables integrated at $I(1)$, and cannot be applied when the variables obtained are intergrade at $I(0)$ and $I(1)$ or mixed order of integration. In this circumstance, Autoregressive Distributed Lag Model (ARDL) should be use because it is applicable for both side of non-stationary times series data. However, ARDL able to receive sufficient numbers of lags in the purpose of capturing the process of data generating at which from general to specific modelling framework.

Pesaran et al (1996) had develop ARDL approach used to cointegration or bound procedure for a long-run equilibrium relationship although the variables are $I(0)$, $I(1)$ or mixed order of integration. The ARDL approach will give more realistic and efficient estimates compared to Johansen Cointegration test. However, ARDL able to identify the cointegrating vector(s) at which every single of the variables stands as single long run equilibrium relationship equation. When cointegrating vector is identified, the ARDL of cointegrating vector will be reparameterized into ECM. The result of reparameterized will gives a short-run relationship and long run equilibrium of the variables for single model. The ARDL model will illustrated as following;

$$y_t = \alpha + \beta x_t + \delta z_t + e_t \tag{3.5}$$

Moreover, the version of error correlation ARDL model shows as following;

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \sum_{i=1}^{p} \beta_i \Delta z_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1} + u_t \tag{3.6}$$

In the equation (3.5), β, δ and e denotes as short run dynamics of model. For the equation (3.6), the λ_s denotes as long run relationship.

However, this ARDL approach will using the Wald Test or Bound Test to identify the long run relationship among the dependent variable and independent variables. The null and alternative hypotheses of the ARDL approach can be written as;

$$H_0: \beta_1 = \beta_2 = \beta_3 = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$$

Where the null hypothesis states that there is no existence of long run relationship and the alternative hypothesis states that there is existence of long run relationship.

Under the ARDL rejection rule, if the computed *F*-statistic result is greater than the upper bound critical value, it can be conclude that there is the existence of the long run relationship among the dependent variable and independent variables due to significant enough to reject the null hypothesis. In contrast, if the computed *F*-statistic result is smaller than the lower bound critical value, it can be conclude that there is no existence of the long run relationship among the dependent variable and independent variables because it does not significant enough to reject the null hypothesis. If the computed *F*-statistic result is between the lower bound critical value and upper bond critical value, it can be conclude that there is inconclusive because indecisive to reject either null hypothesis or alternative hypothesis.

3.3.3 Error Correction Model (ECM)

After conducted an ARDL test, Error Correction Model (ECM) can be derived through simple linear transformation. According to Bhatta & Shrestha (2018), ECM is useful in integrating the short run dynamics by long run equilibrium without losing the long run information and resources. This model able to ignores the problems of spurious relationship which caused from non-stationary time series data.

The following regression equation are Error Correction Models for Y_t and X_t.

$$\Delta Y_t = \mu_Y - \alpha_Y \varepsilon_{t-1} + \sum_{h=1}^{l} a_{1h}\, \Delta Y_{t-h} + \sum_{h=1}^{l} b_{1h}\, \Delta X_{t-h} + u_{Yt} \tag{3.7}$$

$$\Delta X_t = \mu_Y - \alpha_x \varepsilon_{t-1} + \sum_{h=1}^{l} a_{2h}\, \Delta Y_{t-h} + \sum_{h=1}^{l} b_{2h}\, \Delta X_{t-h} + u_{xt} \tag{3.8}$$

Where the u_{Yt} and u_{xt} denote as stationary white noise process with lag l.

However, the coefficients of the cointegration equation are used to estimated long run relationship of the variables while ECM are used to integrates the short run dynamics by long run equilibrium which without losing the long run information as well as ignores the problems of spurious relationship that caused by time series data that were non-stationary. The parameters α_Y and α_x in regression equation (3.7) and (3.8) are the error correction term which is a measurement of speed of adjustment of the variables towards the long run equilibrium.

3.3.4 Diagnostic Tests

3.3.4.1 Jarque-Bera (JB) Normality Test

The Jarque-Bera (JB) normality test is a goodness of fit test which used to test the matches between skewness and kurtosis of the data is matching normal distribution. This test is suit for the data in form of times series, errors in regression model and data in vector.

The JB normality test can be express as following;

$$\frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \tag{3.9}$$

Where the *N* denotes as sample size, *S* denotes as sample skewness and *K* denotes as sample kurtosis.

The null hypothesis and alternative hypothesis of the JB normality test can be stated as following;

$$H_0: Normally\ distributed\ for\ the\ error\ term$$

$$H_1: Not\ normally\ distributed\ for\ the\ error\ term$$

If the computed result of chi-squared statistic *p*-value is greater than 1%, 5% or 10% significant level, the null hypothesis will not be rejected due to insignificant result. It can be conclude that the residual is normally distributed. In contrast, if the result of chi-squared statistic *p*-value is smaller than 1%, 5% or 10% significant level, the null hypothesis will be rejected due to significant enough to reject the null hypothesis. It can be conclude that the residual is not normally distributed.

3.3.4.2 Breusch-Godfrey Serial Correlation LM Test

The Breusch-Godfrey Serial Correlation LM test is used to test for the existence of the autocorrelation problem in the error terms. The null hypothesis and alternative hypothesis of the Breusch-Godfrey Serial Correlation LM test are shown as following;

$$H_0: There\ is\ no\ autocorrelation\ in\ the\ error\ term$$

$$H_1: There\ is\ autocorrelation\ in\ the\ error\ term$$

If computed result of chi-squared statistic *p*-value is greater than 1%, 5% or 10% significant level, there is insignificant to reject the null hypothesis. Therefore, there is no existence of autocorrelation problem in the error term. In contrast, if the computed result of chi-squared statistic *p*-value is lower than 1%, 5% or 10% significant level, there is significant enough to reject the null hypothesis. Thus, it can be concluded that there is existence of autocorrelation problem in the error term.

3.3.4.3 Auto Regressive Conditional Heteroskedasticity (ARCH) Test

In regression analysis, the heteroscedasticity referred as unequal scatter. In specific, heteroscedasticity happen when the systematic change in spread of residuals over the range of the measured values at which the variables does not have the constant variance. The ARCH test is used to test the existence of heteroscedasticity problem in error term. The following shows the null hypothesis and alternative hypothesis of ARCH test.

$$H_0: There\ is\ no\ heteroscedasticity\ problem\ in\ the\ error\ term$$

$$H_1: There\ is\ heteroscedasticity\ problem\ in\ the\ error\ term$$

If the computed result of chi-squared statistic *p*-value is greater than 1%, 5% or 10% significant level, it is insignificant to reject the null hypothesis. Therefore, it can be conclude that there is no existence of the heteroscedasticity problem in the error term. In contrast, if the computed result of chi-squared statistic *p*-value is lower than 1%, 5% or 10% significant level, it is significant enough to reject the null hypothesis. Thus, it can be conclude that there is existence of the heteroscedasticity problem in the error term.

3.3.4.4 Ramsey Regression Equation Specification Error Test (RESET) Test

The Ramsey Reset test generally a specification test for regression model. In specific, it tests the significance of regression of residuals on linear function vectors that gained from least-squares (LS) estimates of dependent variable. According to Volkava and Pankina (2013), they state that Ramsey RESET test is used to tests either the non-linear combinations of fitted values able to explain the response variable. This test is used F-test to proof its hypotheses. The null hypothesis and alternative hypothesis as following;

$$H_0: All\ regression\ coefficient\ of\ non-linear\ terms\ are\ zero$$

$$H_1: All\ regression\ coefficient\ of\ non-linear\ terms\ are\ not\ zero$$

If the computed F-test statistic value is lower than the critical value at 1%, 5% or 10% level, the null hypothesis will not be rejected due to insignificant evidence to reject it. Thus, it can be concluded that model does not suffers from mis-specification problem. In contrast, if the computed F-test statistic value is greater than the critical value at 1%, 5% or 10% level, it is significant enough to reject the null hypothesis. Therefore, it can be concluded that the model is suffers from the mis-specification problem.

3.3.4.5 CUCUM Test

The CUSUM test is a test that use cumulation sum of certain quantity to investigate whether a sequence of values can be modelled as random or not. The CUSUM test is used to test the randomness of sequence of zeroes and ones. The null hypothesis and alternative hypothesis shown as following;

$$H_0: There\ is\ no\ existence\ of\ parameter\ or\ variance\ variability\ in\ the\ model$$

$$H_1: There\ is\ existence\ of\ parameter\ or\ variance\ variability\ in\ the\ model$$

If the cumulative sum had reach beyond the area between two critical lines or outliers of the parameter, the null hypothesis will be rejected. Therefore, it can be concluded that there is existence of parameter variability in model. However, if the cumulative sum does not reach beyond the the area of critical lines or outliers of parameter, the null hypothesis will not be rejected. Therefore, it can be concluded that there is no existence of parameter variability in model.

3.3.5 Granger Causality

Once the variables are cointegrated, there might be a granger causal relationship between variables. The causal relationship can be unidirectional causality such as independent variables affects dependent variable or dependent variable affects independent variables or bidirectional relationship which independent variables and dependent variable affect each other. Granger (1969) had developed Granger Causality test to determine the causal relationship between the variables.

In Table 3.1 will show the null hypothesis and alternative hypothesis of this study. When the computed *p*-value of the variables are smaller than 1%, 5% or 10% significant level, it is significant enough to reject the null hypothesis. Thus, it can be concluded that the independent variable causes the dependent variable. However, when the computed *p*-value of the variables are greater than 1%, 5% or 10% significant level, it is not significant enough to reject the null hypothesis. Hence, it can be said that the independent variable does not cause the dependent variable.

Table 3. 1: Null hypothesis and Alternative hypothesis of Granger Causality

Null hypothesis, H_0	Alternative hypothesis, H_1
Dependent Variables: ΔLCO2	
LGDPPC does not Granger cause LCO2	LGDPPC does Granger cause LCO2
LFDI does not Granger cause LCO2	LFDI does Granger cause LCO2
LPOP does not Granger cause LCO2	LPOP does Granger cause LCO2
LIS does not Granger cause LCO2	LIS does Granger cause LCO2
LEP does not Granger cause LCO2	LEP does Granger cause LCO2
Dependent Variables: ΔLGDPPC	
LCO2 does not Granger cause LGDPPC	LCO2 does Granger cause LGDPPC
LFDI does not Granger cause LGDPPC	LFDI does Granger cause LGDPPC
LPOP does not Granger cause LGDPPC	LPOP does Granger cause LGDPPC
LIS does not Granger cause LGDPPC	LIS does Granger cause LGDPPC
LEP does not Granger cause LGDPPC	LEP does Granger cause LGDPPC
Dependent Variables: ΔLFDI	
LCO2 does not Granger cause LFDI	LCO2 does Granger cause LFDI
LGDPPC does not Granger cause LFDI	LGDPPC does Granger cause LFDI
LPOP does not Granger cause LFDI	LPOP does Granger cause LFDI
LIS does not Granger cause LFDI	LIS does Granger cause LFDI
LEP does not Granger cause LFDI	LEP does Granger cause LFDI
Dependent Variables: ΔLPOP	
LCO2 does not Granger cause LPOP	LCO2 does Granger cause LPOP
LGDPPC does not Granger cause LPOP	LGDPPC does Granger cause LPOP
LFDI does not Granger cause LPOP	LFDI does Granger cause LPOP
LIS does not Granger cause LPOP	LIS does Granger cause LPOP
LEP does not Granger cause LPOP	LEP does Granger cause LPOP
Dependent Variables: ΔLIS	
LCO2 does not Granger cause LIS	LCO2 does Granger cause LIS
LGDPPC does not Granger cause LIS	LGDPPC does Granger cause LIS
LFDI does not Granger cause LIS	LFDI does Granger cause LIS
LPOP does not Granger cause LIS	LPOP does Granger cause LIS
LEP does not Granger cause LIS	LEP does Granger cause LIS
Dependent Variables: ΔLEP	
LCO2 does not Granger cause LEP	LCO2 does Granger cause LEP
LGDPPC does not Granger cause LEP	LGDPPC does Granger cause LEP
LFDI does not Granger cause LEP	LFDI does Granger cause LEP
LPOP does not Granger cause LEP	LPOP does Granger cause LEP
LIS does not Granger cause LEP	LIS does Granger cause LEP

3.3.6 Variance Decomposition

The variance decomposition of $\Delta LCO2$ considered as the output growth of the multisector growth of model;

$$\Delta LCO2_t = w'\alpha + w'D(L)v_t + w'A(L)\varepsilon_t \tag{3.10}$$

Where the α is an $m \times I$ vector of the constants which it is sector-specific mean of growth rates, v_t is the $p \times I$ vector of innovations in macroeconomics variables x_t, $A(L)$ and $D(L)$ denote as matrix polynomials and finally the ε_t is m $\times$ I vector of sector innovations with zero mean.

The variance decomposition is used to understand how important the macroeconomics variables can explain the variability of CO_2 emission. It also used to investigate at what proportion of CO_2 emission can be explain by the macroeconomics variables as well as attributed to other variables.

Besides that, the variance of CO_2 emission can be separate into two forms which are;

I. The variance of CO_2 emission can be explained by macroeconomics variables.
II. The variance of CO_2 emission can be caused because of other factors.

3.4 Data Description

The data of studied variables in this study obtained for period of 39 years which starting from 1980 to 2018. The reason of selecting the time period of these data due to the data of CO_2 emission and its macroeconomic variables are not available after the 2018 which 1 year of lag. The annually data are chosen because the study wanted to investigate the relationship and impact between CO_2 emission and its macroeconomic variables for more than 35 years which it could give more accurate and less bias results for the long-run relationships. The data of time series were obtained from two sources which is World Development Indicator and Global Carbon Atlas.

In this study, Malaysia country will be chosen to investigate the interaction between CO_2 emission and macroeconomic factors. The purpose of selecting Malaysia of this study country because Malaysia now considered as the emerging and developing country at which the problem of CO_2 emission kept on arise. Although Malaysia experience the fluctuation of GDP growth from 1980 to 2018, especially during 1997 facing the most critical financial issues that cause GDP sharply drop from 7.323% to -7.359%, but the CO_2 emission of Malaysia continuously increase. Therefore, many researchers tried to find different factors of CO_2 emission in Malaysia and come out with policies recommendation at which until today it still insufficient to meet the CO_2 emission reduction.

Most of the literatures found that the GDP growth is the main contributor of CO_2 emission for most of the countries. The empirical evidence of previous studies in supporting the relationship between CO_2 emission and GDP growth does not have an accurate conclusive compared to the other elements of pollution such as air and water pollutants. Some of the research explained that there is an existence of linear relationship between CO_2 emission and GDP growth (Azomahou et al., 2006) while other studies reported that an inverted U-shape EKC (Auty, 1985; Stern, 1998; Bruyn and Heintz, 1998; Dinda, 2004; Chin et al., 2018;) and some reported with an N-shape EKC (Beckerman, 1992; Bhagawati, 1993; Panayaotou, 1993).

Besides that, many literatures show that most of studies on the CO_2 emission is used on panel data or cross-sectional data for group of developed and developing countries. The previous studies only provided the general knowledge on how the macroeconomic factors are related to environmental degradation. Thus, these studies could not provide much on the guidance of policy recommendation and implication to each individual country.

Table 3. 2: Macroeconomics Variables Expected Sign and Used by Previous Studies

Macroeconomics Variables	Expected Sign	Previous Study that implemented those Variables
GDP Per Capita	Positive / Negative	Bongaarts (1992), Lantz & Feng (2005), Saboori (2012), Mugableh (2013), Solarin (2014), Cederborg & Snobohm (2016), Ad-Rahim & Teoh (2016), Balogh & Jambor (2017), Chakaramera & Alagidede (2018), Alshubiri (2018), Mikaylov et. Al (2018), Rambeli (2019), Zhou et. Al (2018)
FDI	Positive	Mugableh (2013), Balogh & Jambor (2017), Bento & Moreira (2017), Zhou et. Al (2018), Alshubiri (2018), Chin et. al (2018), Pazienza (2019)
Total Population	Positive	Bongaarts (1992), Lantz & Feng (2005), Wang & Lin (2017), Zhou et. Al (2018), Chakaramera & Alagidede (2018), Sasana & Putri (2018), Mikaylov et. Al (2018)
Electricity Production	Positive	Nordin et. al (2013), Cederborg & Snobohm (2016), Leal (2017), Balogh & Jambor (2017), Zhou et. Al (2018), Chakaramera & Alagidede (2018), Fatima et. al (2018), Sasana & Putri (2018), Rambeli (2019)
Industrial Structure	Negative	Balogh & Jambor (2017), Fatima et. al (2018), Zhou et. Al (2018), Chin et. al (2018)

Based on the Table 3.2, there are two expected signs of GDP per capita towards the CO_2 emission which is positive in the short run and negative in the long run. According to many researchers, the expected of positive in short run and negative in long run is based on the inverted U-shaped EKC hypothesis (Selden & Song, 1994., Baldwin, 1995., Dinda, 2004., Balogh & Jambor, 2017.) At the early stage, the amount of CO_2 emission increases together with increasing in the level of income. It is because the acceleration of level of income lead to intensification on the agriculture as well as other extraction of resources which lead to increase in CO_2 emission. When the stage of take-off is reach, the degradation of resource rate starts to exceed the resource regeneration rate and waste generation will increases in quantity as well as toxicity. When the level of income is reached at the highest, it indicates the people have reached the higher level of living standard and care more on their environmental quality surrounding. Higher standard of living have greater purchasing power at which the people tends to purchase on the items that is more environmental friendly and lead to environmental degradation reduction.

Next, the expected sign of the FDI towards CO_2 emission is expected to be positive for the developing countries especially in Malaysia. Many of the researchers such as Weber et al. (2008), Chebbi et al. (2009), Sharma (2011) and Shahbaz & Leitao (2013) had proved that FDI will positively contribute to CO_2 emission. The reason is because the developing countries with weak environmental policies and regulations wish to gain the advantage of FDI due to the industries such as manufacturing and natural resources extraction will offer lower costs of production and have a comparative advantage among pollution intensive industries which cause increase in CO_2 emission. In contrast, when there is increase in environmental policies and regulation, the production of polluting industries will relocate and go for the countries with weak environmental standards. Therefore, increase in FDI will lead to increase in CO_2 emission.

Moreover, the expected sign of the population is positive towards the CO_2 emission. According to Shi (2001), the population growth contributes to total CO_2 emissions for both developed and developing countries. The positive expected sign of population explains that increase in the population will cause increasing in the human activity such as deforestations, waste burning, transportation and others which leads to more energy demanded. The more energy used by population that go through increasing phase will cause more CO_2 emission and cause environmental degradations. Hence, the increase in the number of total populations for both urban and rural areas will lead to increase in the CO_2 emission.

The expected sign of the electricity production is positive towards the CO_2 emission especially for developing country that strongly depends on natural resources. According to International Energy Agency (2007), share of power production of global energy-related to CO_2 emission has rising from 36% to 41% from 1990 to 2005 respectively and expected to continuously increase to 45% in 2030 if the current trends are still existing. The reason of positive expected sign of electricity production due to the industries especially in developing countries are depends on the primary resources such as fossil-fuels consumption and other human activities that produce high pollutants into the atmosphere. The industries that used massive amount of primary resource to generate energy will increase the atmospheric greenhouse gases such as CO_2 emission concentrated and lead to environmental degradation. Therefore, many studies had been conducted on the energy production that lead to CO_2 emission because it become highly important to researchers and policymakers.

Finally, the expected sign of industrial structure is negative towards CO_2 emission for both developing countries and developed countries. According to many researchers, the industrial structure considered one of the important determinants of CO_2 emission (Adom et al., 2012., Zhu et al., 2014., Mi et al., 2015.). When the industrial structure is adjusted from energy-intensive to non-energy intensive will reduce the CO_2 emission at the efficient and affordable economic cost. The industrial structure is shift to non-energy intensive industrial, the non-renewable energy or fossil fuels consumption will reduce together with the amount of CO_2 emission. Thus, it is important that developing country like Malaysia undergo industrialization process is very beneficial by decrease the amount of fossil fuels consumed and change to renewable resources such as solar power, hydro power and nuclear power.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Unit Root Test

Table 4. 1: Results of ADF, PP and KPSS Test

	Augmented Dickey Fuller (ADF)		**Phillips-Perron (PP)**		**Kwiatkowski, Phillips, Schmidt and Shin (KPSS)**	
Variable	**Level**	**1st Difference**	**Level**	**1st Difference**	**Level**	**1st Difference**
LCO2	-0.924(0)	-6.430(0)***	-0.898(2)	-6.430(3)***	3.833(0)***	0.337(0)
LGDPPC	-2.391(0)	-5.258(0)***	-2.573(1)	-5.200(3)***	0.367(0)***	0.062(0)
LFDI	-1.867(0)	-5.481(0)***	-1.867(0)	-5.443(4)***	1.157(0)***	0.088(0)
LPOP	4.186(0)	-3.343(6)**	2.189(4)	-0.001(3)	80.838(8)***	26.147(8)***
LEP	-1.957(0)	-4.763(0)***	-2.141(1)	-4.720(2)***	1.091(0)***	0.122(0)
LIS	-1.009(0)	-5.295(0)***	-1.083(3)	-5.282(7)***	3.798(0)***	0.203(0)

Notes: Asterisk ***, ** and * denotes rejection at 1%, 5% and 10% significant level. For ADF and KPSS, the number in round brackets ( ) denotes at as lag length while for PP denotes as bandwidth.

Based on the results of unit root test in Table 4.1, under the ADF test, all the variables are not being rejected at level. It indicates that all variables consist of unit root and non-stationary at level due to insignificant to reject the null hypothesis. However, all the variables are being rejected at 1st difference. It indicates that all variables consist of no unit root and become stationary at 1st difference due to significant enough to reject the null hypothesis.

In PP test, all the variables are not being rejected at level. It shows that the variables consist of unit root and non-stationary at level because insignificant to reject the null hypothesis. Moreover, most of the variables are being rejected at 1st difference at which indicates that the variables consist of no unit root and become stationary at

1^{st} difference due to significant enough to reject the null hypothesis. But variable LPOP remain non-stationary at 1st difference.

Results similar with KPSS test, all of the variables are being rejected at level. It shows that the variables consist of unit root and non-stationary at level due to significant enough to reject the null hypothesis. However, most of the variables are not being rejected at 1^{st} difference at which it shows that the variables contain no unit root and become stationary at 1^{st} difference due to insignificant to reject the null hypothesis. But the variables LPOP remain non-stationary at 1^{st} difference.

4.2 ARDL Approach

4.2.1 ARDL Bound Tests for Long-Run Cointegration Analysis

Table 4. 2: Results of ARDL Bound Test

Model	*F-statistics*	
Model 1: LCO_2 =f (LGDPPC, LFDI, LPOP, LIS, LEP)	12.5636*** k=1, n=39	
Critical Value	Lower Bound, *I*(0)	Upper Bound, *I*(1)
1%	3.41	4.68
5%	2.62	3.79
10%	2.26	3.35

Notes: Asterisk *** denotes as significant at 1% level. k and n denote as lag length and number of observations respectively.

The Table 4.2 shows the results of ARDL bound test to test the long-run cointegration relationship. Based on the table above, the computed *F*-statistic value with 12.5636 is significant due to greater than the upper bound, *I*(1) critical value with 4.68 at 1% significant level. It indicates that ARDL approach is suitable to treat these data and it tells that there is a existence of the long-run cointegrating relationship between the CO_2 emission and macroeconomics variables such as GDP per capita, FDI, total population, industrial structure and electricity production in Malaysia. To proceed with ARDL estimation, the empirical model will be further subjected to diagnostic test.

4.3 Error Correction Model (ECM)

Table 4. 3: Results of Error Correction Model

ARDL (1,0,0,3,0,0) Selected based on Akaike info criterion (AIC)			
Dependent Variable: LCO2			
Regressor	**Coefficient**	**Standard Errors**	***t*-Statistic (*p*-value)**
C	-31.1190	3.4261	-9.0828 (0.0000)
LGDPPC(-1)	0.2395**	0.1040	2.3029 (0.0295)
LFDI(-1)	-0.0523**	0.0214	-2.4409 (0.0218)
LPOP(-1)	1.6331**	0.2899	5.6325 (0.000)
LIS(-1)	0.3200	0.3446	0.9287 (0.3616)
LEP(-1)	1.3941**	0.5461	2.5529 (0.0169)
ECT(-3)	-0.9988**	0.3607	-2.7690 (0.0102)

$$\underset{}{LCO2} = \underset{(0.0295)}{0.2395LGDPPC} - \underset{(0.0218)}{0.0523LFDI} + \underset{(0.000)}{1.6331LPOP} + \underset{(0.3616)}{0.3200LIS} + \underset{(0.0169)}{1.3941LEP} - 31.1190$$

The Error-Correction-Term (ECT) is used to measure the speed of adjustment of the data series to back to the equilibrium. Based on Table 4.3, the ECT(-3) had fulfil the three conditions; negative value, between 0 to -1 and statistically significant, which the computed result shows -0.9988 and statistically significant 5% level. In additional, the computed ECT's coefficient value with -1.00 which it signifies a strong and faster speed of adjustment to back to equilibrium. It indicates that the data series takes about 1.0012 years to correct the disequilibrium between dependent variable and independent variables.

Based on Table 4.3, most of the variables such as LGDPPC(-1), LFDI(-1), LPOP(-1) and LEP(-1) are statistically significant at 5% level except LIS(-1) towards LCO2. There is a positive relationship between GDP per capita and CO^2 emission at which increase (decrease) in one unit of GDP per capita will increase (decrease) CO^2 emission by 0.2395 while holding others constant. Next, the result shows existence of negative relationship between FDI and CO^2 emission at which increase (decrease) in one unit of FDI will reduce (increase) CO^2 emission by 0.0523 unit while holding others constant. However, there is a positive relationship between total population and CO^2 emission which rising (declining) in one unit of total population will rising (declining) the CO^2 emission by 1.6331 units while holding others constant. The relationship between industrial structure and CO^2 emission also positive by which increase (decrease) in one unit of industrial structure will increase (decrease) CO^2 emission by 0.3200 unit while holding other constant. Lastly, there also a positive relationship between electricity production and CO^2 emission at which increase (decrease) in one unit of electricity production will increase (decrease) the CO^2 emission by 1.3941 units while holding other constants.

4.4 Diagnostic Tests

Table 4. 4: Results of Diagnostic Tests

Diagnostic Tests	*F*-statistics (*p*-value)
JB	0.0521(0.9743)
BG	0.1768(0.6777)
ARCH	0.8965(0.3506)
RESET	1.7314(0.1885)
CUSUM	Stable
$CUSUM^2$	Stable

Notes: JB denotes as Jarque-Bera statistic for residual normality test. BG denotes as Breusch-Godfrey Serial Correlation LM test. ARCH is the ARCH Heteroskedasticity test. RESET refers to Ramsey RESET specification test. Asterisk ** indicates significant at 5% levels.

4.4.1 Jarque-Bera Normality Test

Based on the Table 4.4 diagnostic tests, the computed result of JB normality test shows that the *F*-statistic with value of 0.0521 is lower than critical value at 5% significant level and *p*-value with 0.9743 is greater than 0.05. Therefore, the null hypothesis will not be rejected due to insignificant evidence and can be conclude that there is no normality distribution problem in the model.

4.4.2 Breusch-Godfrey Serial Correlation LM Test

In the Table 4.4 diagnostic tests, the Breusch-Godfrey serial correlation LM test has computed a result of F-statistic with 0.1768 is lower than critical value at 5% significant level and *p*-value with 0.6777 is greater than 0.05. Thus, the null hypothesis will not be rejected because insignificant evidence and it can be said that there is an existence of the autocorrelation problem in error term.

4.4.3 Auto Regressive Conditional Heteroskedasticity (ARCH) Test

The ARCH heteroskedasticity test have been used to identify does the variables used suffered problem of heteroskedasticity. So, the projected *F*-statistic and *p*-value of ARCH test in Table 4.4 is 0.8965 which lower than critical value at 5%

significant level and 0.3506 is greater than 0.05, respectively. Hence, it can be concluded that time series data does not suffered from the problem of heteroskedasticity.

4.4.4 Ramsey RESET Test

The time series data however, will undergoes the Ramsey RESET test for the purpose to check does there any mis-specification problem exist in the data. The computed result indicates that the time series data unable to reject the null hypothesis as *F*-statistic with 1.7314 is lower than critical value at 5% significant level and *p*-value with 0.1885 is greater than 0.05. Therefore, the time series data have no problem of mis-specification.

4.4.5 CUSUM Test and CUSUM^2 Test

Based on Figure 4.1 and Figure 4.2, the CUSUM and CUSUM^2 will be used to capture the outliers when there is existences of parameter or variance variability in the data. As projected in Figure 4.1 and 4.2 that have been tested under CUSUM and CUSUM^2, there is no existence of outlier of parameter and variance. Hence, it can be said the model in this study is stable.

Figure 4. 1: CUSUM Test

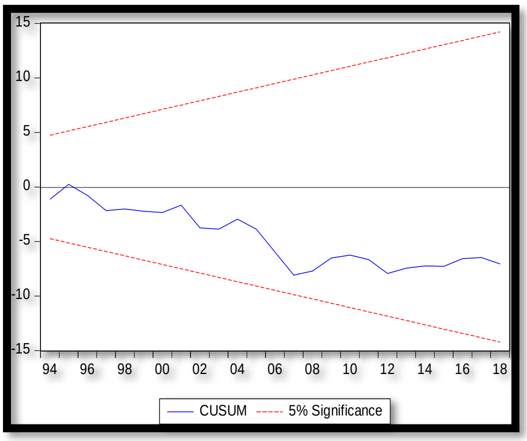
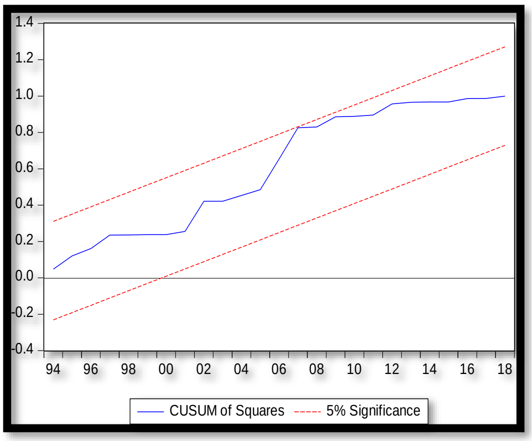


Figure 4. 2: CUSUM^2 Test



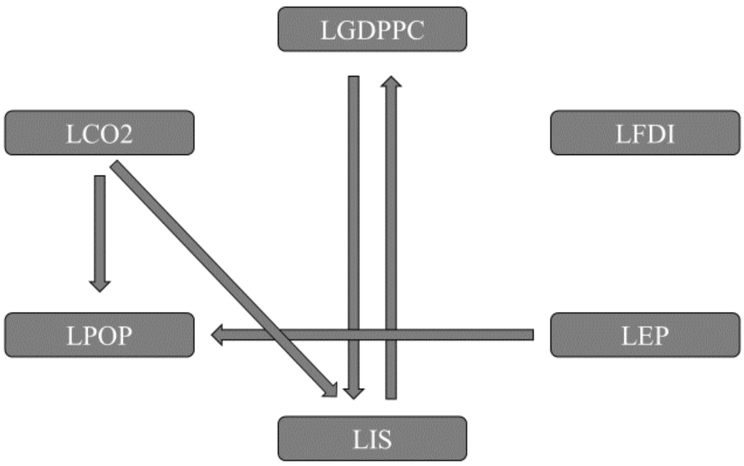
4.5 Granger Causality / Block Exogeneity Wald Tests

Table 4. 5: Results of Granger Causality

Dependent Variable	*Chi-sq (p-value)*					
	ΔLCO2	**ΔLGDPPC**	**ΔLFDI**	**ΔLPOP**	**ΔLIS**	**ΔLEP**
ΔLCO2	-	5.1764 (0.0752)	0.1564 (0.9248)	1.1068 (0.5702)	0.7708 (0.6820)	2.2508 (0.3245)
ΔLGDPPC	3.2151 (0.2004)	-	3.6202 (0.1636)	0.1040 (0.9493)	15.7806** (0.0004)	2.6049 (0.2719)
ΔLFDI	4.4681 (0.1071)	4.2072 (0.5548)	-	1.1782 (0.5548)	2.5553 (0.2787)	0.3686 (0.8317)
ΔLPOP	12.2466** (0.0022)	2.7954 (0.2472)	0.5154 (0.7728)	-	1.4215 (0.4913)	29.3121** (0.0000)
ΔLIS	6.9340** (0.0312)	12.9093** (0.0016)	3.7381 (0.1543)	1.7150 (0.4242)	-	2.7971 (0.2470)
ΔLEP	2.7550 (0.2522)	1.1680 (0.5577)	0.6642 (0.7174)	0.5589 (0.7562)	1.6201 (0.4448)	-

Notes: asterisk ** indicates rejection at 5% significant level.

Figure 4. 3: Granger Causality Channel Among Variables



Based on the Figure 4.3, the results show that there are 3 unidirectional causality between variables and 1 bidirectional causality between the variables. There is existence of unidirectional causality running from CO^2 emission to total population, from CO2 emission to industrial structure and from electricity production to total population. However, there also existence of bidirectional causality among the GDP per capita and industrial structure.

4.6 Variance Decomposition

Table 4. 6: Results of Variance Decomposition

Period	Due to Innovation in:						
	LCO2	LGDPPC	LFDI	LPOP	LIS	LEP	Cumulative
Variance Decomposition of LCO2							
1	**100.000**	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**
5	**85.6423**	4.8877	3.1254	2.5459	2.2686	1.5299	**14.3577**
10	**67.3997**	16.0443	3.4871	6.7926	2.1395	4.1367	**32.6003**
20	**57.6433**	16.7060	6.1693	9.6266	3.9699	5.8849	**42.3567**
30	**56.5207**	16.8777	6.1664	9.8563	4.7933	5.7856	**43.4793**
50	**55.0481**	16.7285	6.1650	11.0207	4.9215	6.1161	**44.9519**
Variance Decomposition of LGDPPC							
1	18.7547	**81.2453**	0.0000	0.0000	0.0000	0.0000	**18.7547**
5	19.5613	**45.5863**	0.7282	4.1725	28.1953	1.7563	**54.4137**
10	20.1884	**42.3860**	5.4956	3.8343	26.2501	1.8456	**57.6140**
20	20.2404	**41.3438**	6.0980	5.4162	24.4077	2.4939	**58.6562**
30	19.4392	**40.2874**	6.6831	6.6108	23.7540	3.2255	**59.7126**
50	19.3559	**39.9026**	6.6624	6.9976	23.7891	3.2924	**60.0974**
Variance Decomposition of LFDI							
1	12.5931	0.1333	**87.2735**	0.0000	0.0000	0.0000	**12.7265**
5	25.9731	9.2084	**58.7250**	1.5474	2.3116	2.2345	**41.2750**
10	24.7094	9.2922	**56.3396**	1.9802	4.5787	3.1000	**43.6604**
20	24.8749	13.9549	**50.2352**	2.5531	4.9232	3.4586	**49.7648**
30	24.5948	14.1760	**49.9119**	2.6080	5.1634	3.5459	**50.0881**
50	24.5199	14.5446	**49.4954**	2.6720	5.1639	3.6043	**50.5046**
Variance Decomposition of LPOP							
1	5.2502	0.1412	10.0402	**84.5684**	0.0000	0.0000	**15.4316**
5	1.8708	8.2601	9.5707	**67.0231**	0.5425	12.7329	**32.9769**
10	5.0715	15.1887	2.5989	**57.7492**	2.5122	16.8795	**42.2508**
20	3.2795	14.0450	4.2739	**51.4197**	8.2313	18.7506	**48.5803**
30	3.0196	11.2094	3.8876	**51.1534**	12.4081	18.3219	**48.8466**
50	2.5996	9.8153	3.3436	**52.5058**	13.4129	18.3229	**47.4942**
Variance Decomposition of LIS							
1	6.7942	0.0390	2.7059	0.8472	**89.6137**	0.0000	**10.3863**
5	10.3763	25.0984	6.1289	2.3725	**54.0971**	1.9267	**45.9029**
10	18.9968	34.9346	7.0604	3.6008	**31.9288**	3.4786	**68.0712**
20	17.2939	34.3906	12.7225	4.0809	**26.9707**	4.5414	**73.0293**
30	17.6811	35.0788	12.6478	4.3430	**25.5344**	4.7149	**74.4656**
50	17.6583	34.9792	12.9057	4.3505	**25.3598**	4.7466	**74.6402**
Variance Decomposition of LEP							
1	17.0057	0.5344	6.6857	43.8307	3.4502	**28.4933**	**71.5067**
5	31.0170	3.6674	8.6600	30.8120	6.7941	**19.0495**	**80.9505**
10	30.1309	13.1023	7.4386	25.3357	8.1229	**15.8697**	**84.1303**
20	27.2837	17.4842	10.2406	22.6112	7.5634	**14.8170**	**85.1830**
30	27.3151	18.1642	10.2581	21.9866	7.8158	**14.4602**	**85.5398**
50	27.1644	18.3366	10.4832	21.8365	7.7870	**14.3924**	**85.6076**

Notes: The last column provides the percentage of forecast error variances of each variables explained collectively by the other variables. The column represents the impact of own shock.

The exogenous are the variables that have greater power in influencing other variables in the systems, where the variations of the variable are mostly caused by itself. Based on Table 4.6, the LCO2 is the most exogenous among the variables and the fluctuation of LCO2 shows to be the main explained by its own shock. The LCO2 is the most exogenous variables because the computed result shows that it has the highest variance with 55.05% of ability in influencing the other variables and with 44.95% of other variables can influence LCO2.

In contrast, the endogenous are the variables that have the values and determined mostly by other variables in the system, where the variations of the variables are mostly caused by other variables. Based on the Table 4.6, LEP is strongly endogenous variables due to lowest variance with 14.39% of ability in influencing other variables and with 85.61% of other variables can influence LEP.

The sequence of the exogeneity to endogeneity based on the table 4.6 show as following:

I. LCO2

II. LPOP

III. LFDI

IV. LGDPPC

V. LIS

VI. LEP

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Introduction

The overall of carried out data in this study on determination of macroeconomics variables and CO_2 emission will be concluded in this chapter. However, the recommendation and limitation of the study will be discussed in section 5.3 and 5.4.

5.2 Summary of the Study

This study has been conducted to investigate the determinants of CO_2 emission in Malaysia. However, five independents variables such as GDP per capita, FDI, population, industrial structure and electricity production have been used to examine the relations towards dependent variable such as CO_2 emission. The times series data of this study will be span from 1980 to 2018 which consist of 39 observations.

Throughout the study, the time series data have gone through few stages of analysis. The unit root test, ARDL bound test to test long run cointegration, diagnostic tests, error correction model (ECM), granger causality and variance decomposition. The following will summarize the results of empirical;

In this study, 3 type of unit root tests such as ADF, PP and KPSS being used to identify the existence of unit root problem as well as stationarity of the variables. The empirical results of ADF shows that there is a existence of unit root problems at level while the variables in first difference are integrated which is $I(1)$. However, in PP and KPSS also indicates existence of unit root problem at level. But the variables have a mixed order integration at first difference which is *I*(1) and *I*(0). Thus, the variables of this study are mixed variables or mixed order integration.

The ARDL approach will be used in this study after passing the unit root test with mixed variables. ARDL approach is used to test the long run cointegration relationship. The empirical result of ARDL approach indicates existence of long run relationship between the dependent variable and independent variables. Thus, there is long run relationship towards affecting the CO_2 in Malaysia.

Next, after ARDL approach had been conducted, the diagnostic test will be used to identify is there existence of any problem within the data. First, the Jarque-Bera normality test conducted shows the variables is normally distributed. Secondly, Breusch-Godfrey Serial Correlation LM test used to check the existence of autocorrelation problem in the data series and the empirical result were not able to reject the null hypothesis. Thus, autocorrelation problem is not existed in the data series. The ARCH test also being used in this study to check if there is any existence of heteroskedasticity problem in this data series and the result able to prove no heteroskedasticity problem. Moreover, Ramsey RESET test used to investigate does any of mis-specification problem exist in the data series. The result of this test indicates there is no mis-specification problem due to insignificant to reject null hypothesis. Lastly, CUSUM test and $CUSUM^2$ test used to see the stability of data series in this study and both results depict that there is no outlier capture in both CUSUM and $CUSUM^2$ test. Hence, it can be concluded that the data is stable.

Once the diagnostic tests detect no problems in data series, Error Correction Model had been conducted. The ECM used shows that all of the variables contributed to CO_2 emission except LFDI. However, the ECT detects that there is a long run relationship due to fulfilment of three criteria in ECT which the coefficient value is negative value, less than one as well as significant value greater than significant level at 5 per cent. The existences of long run relationship have a consistence results with the finding of Ang (2002) study long run equilibrium relationship in Malaysia, Alam et al. (2012) study in Bangladesh and Halicioglu (2009) study in Turkey. Thus, it concluded that there is long run relationship among the variables.

Firstly, ECM tells that there is a positive relationship between CO_2 emission and income per capita which increase in income level will lead to greater CO_2 emission whereas the invented-U shape relationship can be found in the short run for Malaysia. This is because most of the people with higher income level does not have similar knowledge and attitude towards environmental protection as well as weak willingness to pay for green products. These results are similar with the findings of Ang (2009) and Wang & Lin (2016) study in China, Hwang & Yoo (2014) study in Indonesia, Ito (2017) study in Japan and Mitic et al. (2017). Next, the empirical results depict that relationship between FDI and CO_2 emission is negatively correlated which is in line with the finding of Liang (2008), Shahbaz et al. (2018) and Sung et al. (2018). It shows that Pollution Haven Hypothesis does not applied in Malaysia cases due to FDI impact are beneficial to environment. The industrial sectors in Malaysia have the ability to implementing the green technology to produce less CO_2 emissions while the productions are still able to improve and attract more FDI. According to the finding, population growth is one of highest contributor to CO_2 emission in Malaysia cases. Similar to the finding of Bongraarts (1992), Hang & Sheng (2011), Wang et al. (2013), Ohlan (2015) and Wang & Lin (2016), they stated that increase in the population growth will cause more damage to the environment and brings global warming because higher productions and consumptions activities conducted daily. In Malaysia cases, Safaai et al. (2010) states that Malaysia population increase by 2.1% from 2010 to 2020 had increase CO_2 emissions because of high energy intensity, high energy production and consumption. The daily human activities in Malaysia such as deforestation, open agricultural burning, transportation, usage of air conditional, burning fossil fuel, burning coal and etc could produce more greenhouse gases that will worsen the global warming. Thus, Malaysia's population growth is one of major factor contributed to CO_2 emission. The results of ECM also show that electricity production is an important factor that contribute to CO_2 emission. It also shows in the finding of Zhang & Cheng (2009), Naim et al. (2016) and Ahmad et al. (2016) which mentions that the electricity production increase with population will lead to more CO_2 emission. Malaysia is a country depend highly on natural gas and coal to produce electricity. The electricity production by burning raw resources such as natural gas, coal source and oil to produce electric supply emit more of CO_2 emission which cause Malaysia temperature sharply increased. Finally, the results show a positive relationship between industrial structure and CO_2 emission in Malaysia. Similar to the finding of Geng et al. (2013) and Zhang and Da (2015) in China. They explained that the adjustments of industrial structural cause more CO_2 emission due to dominant positions of high-carbon industries in the industrials revolutions. Most of the industrial structures in Malaysia are still practicing high-carbon industries and unwilling to switch their industrial structures to low-carbon industries because it is still unnecessary to switch as well as reduce the production cost and increase profit. Thus, all of variables contributes to CO_2 emission especially population growth and except the FDI in Malaysia cases.

After the ECM had been used to form a normalized equation to identify the relationship between dependent variable and independent variables, the data of this study will be used under the Granger Causality test based on Block Exogeneity Wald test. The Granger Causality test result tells that there is existence of short run relationship between the CO_2 emission, GDP per capita, population, industrial structure and electricity production in Malaysia. Only FDI have no short run relationship towards the other variables which similarly with the finding of Zhou et al. (2018) which study in China. It means that FDI will appear to have the long run relationship towards CO_2 emission which FDI able to provide benefits to the environment quality.

Lastly, the variance decomposition is used to see the sequence of variables in explaining the variability of CO_2 emission. The empirical results of the variance decomposition depict that the CO_2 emission is the exogenous variable and electricity production is the most endogenous variable. The population growth in Malaysia is an important variable in explaining the variability of CO_2 emission. As mention before, population growth in Malaysia will keep on increasing which lead to more production and consumption activities. This will cause more environmental degradation in Malaysia and policy makers should focus on CO_2 emission reduction as well as implemented effective policies especially in high-carbon intensity industries and power production. Thus, the sequence of variables in influencing CO_2 emission is followed by population, FDI, GDP per capita, industrial structure and electricity production.

5.3 Recommendations and Policy Implementation of the Study

In this part, few of the recommendation and policy implementation can be applied in Malaysia towards the reduction of CO_2 emission to reduce further global warming problems. Although Malaysia is a developing country that moving towards developed country, the Malaysia's economy growth must be in line with the green economy growth which most of the developed countries has been practiced successfully such as Singapore, Japan, South Korea and United Kingdom. The purpose is to create a better, healthier and safer environment to the future generation as well as drive Malaysia economy even further.

The policy makers and planners should generate rapid expansion in using renewable energy in Malaysia's electrical matrix especially to the power plant that are highly based on scarce resources. This is because the power plants that highly based on scarce resources able to reduce the amount of greenhouse gases emission such as CO_2 emission and slowly transform as well as expand into green power plant that capable to produce clean energy. It also able to help in reducing environmental degradation which energy source based on oil and natural gas in Malaysia could be decrease. Thus, the environment quality could be improve and sustain for the better future economy.

Moreover, Malaysia also should focus on the implementation of control measure of CO_2 emission which necessary in curbing the problem of global warming. The population growth in Malaysia expected will keep in raising in increasing rate. Higher number of population growth also lead to higher productions and consumptions that will cause more CO_2 emission. Industries are force to produce more production to match with the demand and supply of Malaysia market. At this point, the control measure such as Cap-and-Trade policy must be implemented to the industries in reducing and limiting CO_2 emission. The industries are required to cap their greenhouse gases emitted into atmosphere at certain limitation and the cap will become more stricter over time. If the industries wanted to produce more greenhouse gases, they have to buy the allowances from other industries that sell allowance to further emit at certain limitation. Thus, the industries have a strong incentive in reducing cost and cutting greenhouse gases at cost-effective ways.

Based on this study, FDI is able to help in reducing the CO_2 emission in Malaysia. Government should play an important role in attracting and encouraging more FDI into Malaysia to reduce CO_2 emission. This is because higher FDI in Malaysia can increase and improve the optimal infrastructure investment in industries that operate within Malaysia. The industries become more beneficial and able to change their high energy intensive technologies into less energy intensive technologies. Hence, with efficient green technology able to reduce the CO_2 emission through greater FDI (Mikayilov, Galeotti & Hasanow, 2018).

Besides, reducing CO_2 emission cannot focus on industrial sectors alone and residential sectors also play an important role towards CO_2 emission reduction. So, the residents must switch their consumption behaviour together in achieving the goal. Most of residents consumed more energy power just to obtain a comfortable standard of living without consider on environmental degradation. The household have to modify their consumption pattern of goods and services. They must efficiently reduce and change in purchasing carbon-intensive of goods and services to less carbon-intensive of goods and services. Furthermore, government also must rapidly monitor on household consumption that could cause more CO_2 emission (Farah & Allely, 2003). The government have to raise more awareness among residents towards important of energy conservation and low carbon economy. Therefore, government should reinforce new law of environmental protection to reduce CO_2 emission towards fully achieving green economy in Malaysia (Dong & Zao, 2016).

In the future study, the researchers can conduct the study of CO_2 emission in Malaysia to produce better and more accurate results to forecast on the trends or behaviours of determinants towards CO_2 emission in Malaysia. In additional, researchers can use big sample data in conducting the study on CO_2 emission. This is because most of the studies using panel data and small sample data to investigate relationship of CO_2 emission and other determinants in Malaysia.

Finally, the future study also can expand and explore more variables that have strongly affected CO_2 emission in Malaysia. For example, future study can study on how the Covid-19 affect CO_2 emission in Malaysia. Throughout the observation, during Covid-19 outbreak most of the industries are required to shutdown and close most of the economy activities. Due to lockdown, the CO_2 emission sharply decrease for more than 2 months and the global ecosystem slowly healing by itself. Thus, policy makers and planners could use the information to come out with a new policy to reduce CO_2 emission in Malaysia.

5.4 Limitations of The Study

Throughout this study, there are some limitations or constraint that can be improve in the future study. The first limitation of this study is the limited data available. During the earlier stage of this study, both consumer price index and financial development were the variables being chosen to study the relationship towards CO_2 emission in this research. However, these data lead to uncooperative results after running by system which causing the equation impossible to regress in this research. Therefore, the variables are required to change in order to proceed with this study.

The second limitation of this study is the timing of this study. The other research often had limited time to complete the study. In contrast of this study, delay of research activity due to Covid-19 pandemic that cause Movement Control Order (MCO) have to be implemented to stop the spread of the virus. This will force every educational sector including Universities have to lockdown and not allow to operate. To conduct and produce a good research must frequently seeking Supervisor to have a supervised on this study. Due to MCO, supervision consultancy with Supervisor cannot be held. Moreover, the Centre for Academic Information Services (CAIS) in Universiti Malaysia Sarawak were closed and students are not allowed to access the facilities and services they have due to MCO. Hence, the research required longer timing to complete.

Lastly, there also lack of the journals which lead to difficulties in searching for information on the relationship between CO_2 emission and other variables. Most of the journals are using different variables such as transportation, agricultures, services, and etc. Moreover, different study will have a different method to conduct empirical analysis which provide the different outcome. Thus, this research somehow required to take more time to dig on the information and resources to support on this study.

Reference

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.

Ahmad, A, A., Talib, S, A, A., & Masdek, N, R, N, M. (2018). *Malaysian Government Initiatives to Reduce the Impact of Climate Change Towards the Agriculture Industry.* Retrieve from http://ap.fftc.agnet.org/ap_db.php?id=913

Akerboom, S., Botzen, W., Buijze, A., Michels, A. & Rijswick, W, V. (2020). Meeting goals of sustainability policy: CO2 emissions reduction, cost-effectiveness and societal acceptance. An analysis of the proposal to phase-out coal in the Netherlands. *Energy Policy, 128*(2020): 111210.

Alshubiri, F., & Elheddad, M. (2019). Foreign finance, economic growth and CO2 emissions Nexus in OECD countries. International Journal of Climate Change Strategies and Management. *International Journal of Climate Change Strategies and Management, 12(2):* 1756-8692.

Amran, A., Zainuddin, Z., & Zailani, S, H, M. (2013). Carbon Trading in Malaysia: Review of Policies and Practices. *Sustainable Development*, 21(3), 183-192.

Anjana, C. (2017). *The Asian Financial Crisis 1997 Explained.* Retrieved from https://www.flymalaysia.org/asian-financial-crisis-1997-explained/

Balogh, J. M., & Jámbor, A. (2017). Determinants of CO2 emission: A global evidence. *International Journal of Energy Economics and Policy, 7*(5), 217-226.

Bongaarts, J. (1992). Population growth and global warming. *population and Development Review, 18(2),* 299-319.

Cerdeira Bento, J. P. (2014). The determinants of CO2 emissions: empirical evidence from Italy. *Munich Personal RePec Archive*, *59166,* 17-47.

Cerdeira Bento, J. P., & Moreira, A. (2018). Environmental impact of FDI–the case of US subsidiaries. Multinational Business Review. *Multinational Business Review, 27(3),* 226-246.

Chakamera, C., & Alagidede, P. (2018). Electricity crisis and the effect of CO2 emissions on infrastructure-growth nexus in Sub Saharan Africa. *Renewable and Sustainable Energy Reviews, 94*, 945-958.

Chin, M. Y., Puah, C. H., Teo, C. L., & Joseph, J. (2018). The Determinants of CO2 Emissions in Malaysia: A New Aspect. *International Journal of Energy Economics and Policy*, *8*(1), 190-194.

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

Fatima, T., Xia, E., & Ahad, M. (2018). An aggregate and disaggregate energy consumption, industrial growth and CO_2 emission: Fresh evidence from structural breaks and combined cointegration for China. *International Journal of Energy Sector Management*, 12(1), 130-150.

Hossain, M. S., Kibria, M. G., & Islam, M. S. (2018). DOES GLOBALIZATION AFFECT THE ECONOMIC GROWTH OF BANGLADESH? - AN ECONOMETRIC ANALYSIS. *Asian Economic and Financial Review*, *8*(12), 1384-1393.

Hyder, J, P. (2019). *Earth Summit (1992)*. Retrieved from https://www.encyclopedia.com/environment/energy-government-and-defense-magazines/earth-summit-1992

Lantz, V., & Feng, Q. (2006). Assessing income, population, and technology impacts on CO2 emissions in Canada: where's the EKC?. *Ecological Economics*, *57*(2), 229-238.

Leal, P. H., Marques, A. C., & Fuinhas, J. A. (2018). How economic growth in Australia reacts to CO2 emissions, fossil fuels and renewable energy consumption. *International Journal of Energy Sector Management*, *12*(4), 696-713.

Li, W., Wang, W., Wang, Y., & Qin, Y. (2017). Industrial structure, technological progress and CO 2 emissions in China: Analysis based on the STIRPAT framework. *Natural Hazards, 88*(3), 1545-1564.

Malaysia's CO2 Emissions Among Highest In ASEAN, Low Carbon Mobility Solution Needed. (2019). Retrieved from https://www.carlist.my/news/malaysia-s-co2-emissions-among-highest-in-asean-low-carbon-mobility-solutions-needed-65838/65838/

Malla, S. (2009). CO2 emissions from electricity generation in seven Asia-Pacific and North American countries: A decomposition analysis. *Energy Policy*, *37*(1), 1-9.

Mendonca, A, K, S., Barni, G, D, A, C., Moro, M, F., Bornia, A, C., Kupek, E. & Fernandes, L. (2019). Hierarchical modelling of the 50 largest economics to verify the impact of GDP, population and renewable energy generation in CO_2 emissions. *Sustainable Production and Consumption, 287*(19): 2-21.

Mikayilov, J. I., Galeotti, M., & Hasanov, F. J. (2018). The impact of economic growth on CO2 emissions in Azerbaijan. *Journal of cleaner production*, *197*, 1558-1572.

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

Mustapa, S. I., & Bekhet, H. A. (2015). Investigating factors affecting CO2 emissions in Malaysian road transport sector. *International Journal of Energy Economics and Policy*, *5*(4), 1073-1083.

Nordin, S. K. S., Samat, K. F., Ismail, S. F., Hamzah, K., Halim, B. A., & Kun, S. S. (2015, May). Determinants of CO2 emissions in ASEAN countries using energy and mining indicators. In *AIP Conference Proceedings*, 1660(1), p. 090035.

Österholm, P., & Hjalmarsson, E. (2007). *Testing for cointegration using the Johansen methodology when variables are near-integrated* (No. 7-141). International Monetary Fund.

Pazienza, P. (2019). The impact of FDI in the OECD manufacturing sector on CO2 emission: Evidence and policy issues. *Environmental Impact Assessment Review*, *77*, 60-68.

Rambeli, N., Ramli, A. H., Hashim, E., Jalil, N. A., & Tha, G. P. (2019). Does Energy Consumption Influence the CO2 Emission?. *Sciences*, *9*(3), 329-335.

Ren, F, R., Tian, Z., Liu, J. & Shen, Y, T. (2019). Analysis of CO2 emission reduction contribution and efficiency of China's solar photovoltaic industry: Based on Input-output perspective. *Energy, 199*(2020): 117493.

Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. *Energy policy*, *51*, 184-191.

Safaai, N. S. M., Noor, Z. Z., Hashim, H., Ujang, Z., & Talib, J. (2011). Projection of CO2 emissions in Malaysia. *Environmental Progress & Sustainable Energy, 30*(4), 658-665.

Sasana, H., & Putri, A. E. (2018). The increase of energy consumption and carbon dioxide (CO2) emission in Indonesia. *In E3S Web of Conferences 31*, p.01008.

Shrestha, M. B., & Bhatta, G. R. (2017). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science, 4*(2018), 71-89.

Shrestha, M. B., & Bhatta, G. R. (2018). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science*, *4*(2), 71-89.

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

Wang, A., & Lin, B. (2017). Assessing CO2 emissions in China's commercial sector: Determinants and reduction strategies. *Journal of cleaner production, 164*, 1542-1552.

Zhao, T. & Dong, Y. (2016). Difference analysis of the relationship between household per capita income, per capita expenditure and per capita CO_2 emissions in China: 1997-2014. *Atmospheric Pollution Research, xxx*(2016): 1-10.

Zhou, C., Wang, S., & Feng, K. (2018). Examining the socioeconomic determinants of CO_2 emissions in China: A historical and prospective analysis. *Resources, Conservation and Recycling 130*(2018): 1-11.