DETERMINANTS OF CLIMATE CHANGE: IS FINANCIAL DEVELOPMENT A SIGNIFICANT CONTRIBUTOR TO CLIMATE CHANGE?

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DECLARATION

We hereby declare that:

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

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

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

(4) The word count of this research report is 19408 words.

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LIST OF ABBREVIATIONS

ARDL	Autoregressive Distributed Lags
ASEAN	Association of Southeast Asian Nations
BLUE	Best Linear Unbiased Estimators
BP-LM	Breusch-Pagan Lagrange Multiplier
BRIC	Brazil, Russia, India and China
BRICS	Brazil, Russia, India, China and South Africa
CLRM	Classical Linear Regression Model
CO_2	Carbon Dioxide
CRI	Climate Risk Index
EKC	Environmental Kuznets Curve
ESG	Environmental, Social and Corporate Governance
FD	Financial Development
FDI	Foreign Direct Investment
FEM	Fixed Effect Model
GDP	Gross Domestic Product
GHG	Greenhouses Gases
GMM	Generalized *Method* of Moment

IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPAT	Impact = Population · Affluence · Technology
IRENA	International Renewable Energy Arena
JB	Jarque-Bera
LLC	Levin-Lin-Chu
LM	Lagrange Multiplier
LR	Likelihood Ratio
OLS	Ordinary Least Squares
PETRONAS	Petroliam Nasional Berhad
POLS	Pooled Ordinary Least Square
POP	Population Size
PSTR	Panel Smooth Transition Regression
PV	Photovoltaics
R&D	Research and Development
RE	Renewable Energy
REM	Random Effect Model
SRES	Special Report on Emission Scenarios
TWh	Terawatt-hours
USD	United State Dollar
VIF	Variance Inflation Factor

PREFACE

Today, the issue of climate change is no longer just a piece of news but something that is happening around the globe. Due to aggressive development in the ASEAN countries, environmental issues have been raised due to the mismanagement of development. This research studies about the determinants of climate change and the role of financial development in this issue.

This research has 3 sections:

First Section: Preliminary pages that include copyright pages, declaration, acknowledgement, dedication, contents page, list of tables, list of figures, list of abbreviation, preface and abstract.

Second section: The content of the research.
Chapter 1: Research Overview
Chapter 2: Literature Review
Chapter 3: Methodology of Study
Chapter 4: Analysis of Data
Chapter 5: Conclusion

Third section: This section consists of references as well as appendices.

This research provides detailed information for future researchers that wish to conduct research on the issue of climate change.

ABSTRACT

The main purpose of this study is to study the determinants of climate change in 5 of the ASEAN countries from the period of 1996 to 2015. It also studies about the significance of Financial Development in the issue of climate change and how it interacts with other determinants and further causes climate change. The data used in this research is secondary data with a total number of observations of 100. In this research, some variables have been found to be significant in affecting climate change and some variables have been found to interact with financial development and further affects climate change. The emission of carbon dioxide would increase when foreign direct investment and economic growth interacts with financial development. This shows that with higher financial development, foreign direct investment and economic growth would further cause climate change in the 5 ASEAN countries. However, when renewable energy interacts with financial development, it would decrease the emission of carbon dioxide. This means that when the country is developed, it would have enough resources to develop renewable energy and reduce climate change effectively. As a conclusion, financial development does play a significant role in the issue of climate change in the 5 ASEAN countries.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

Chapter 1 commences by introducing the current climate change situation in selected ASEAN countries followed by problem statements, research questions, research objectives and significance of study. The last part of this chapter outlines the layout of each chapter for this research.

1.1 Research Background

In this globalization and industrial revolution era, both developed countries and developing countries are efficient and effective in the utilization of resources, engaging in large-scale production of manufactured goods, declining in production cost and having rapid growth in economy (Hassan, 2009). However, everything has its own opportunity costs. Industrial revolution leads to environmental degradation. Not only that, in order to improve a country's economy, it required large amount of energy consumption, mostly achieved by consumptions of fossil fuels which caused environment pollutants such as carbon dioxide (CO_2) emissions, and eventually lead to global warming and climate change (Choudhary, Chauhan & Kushwah, 2015). Based on Gokmenoglu and Sadeghleh (2019), extreme competition among countries, enhancement in growth of developing countries, market liberalization and globalization accelerated these developments. The most observable effect of industrial revolution is climate change in which the frequency of occurrence has been increased year by year.

Climate change is the greatest environmental warning to human which is caused by the formation and increment of greenhouse gases (GHG). According to Overview of Greenhouse Gases, GHG have the property to absorb and trap infrared radiation which is net heat energy emitted by Earth's surface and reradiating it back to Earth's surface.

GHG comprise of carbon dioxide, water vapor and methane. The major sources of greenhouse gases come from combustion of fossil fuels and destruction of rainforests that contain large amount of carbon. GHG have increased steadily in atmospheric concentrations since Industrial Revolution. This is because most of the industrial countries such as United States will tend to burn fossil fuels for the purpose of generation of electricity and heat as well as for the use of transportation. In the last few decades, emissions of GHG and CO_2 have risen nearly 1.6% every year because of big consumption of fossil fuels, which increases 1.9% yearly. According to Intergovernmental Panel on Climate Change (IPCC) (2018), activities of human are forecasted to make around 1.0°C of global warming above the levels of pre-industrial, with a range of 0.8°C to 1.2°C. Global warming might reach 1.5°C between 2030 and 2052 if it continues to rise at the current rate. Human around the world have to encounter the reality of climate variability occurred in most of the country. According to Global Climate Risk Index (2019), at least 526,000 people passed away worldwide as an impact of more than 11,500 extreme weather events between 1998 and 2017. The consequences of climate change have already been felt. Polar ice shields are melting, temperatures are increasing, sea levels are rising, and glaciers are shrinking. These are the direct consequences of climate change that can be witnessed by all the residents in the world.

According to International Monetary Fund (IMF) 2018, Southeast Asia is the most vulnerable region to be affected by climate change. According to the Global Climate Risk Index 2019, among the 10 countries in ASEAN, Vietnam, Indonesia, Philippines and Thailand are most affected by climate change in the world and this shows the seriousness of climate change in ASEAN region. One of the factors that contribute to climate change in ASEAN is deforestation especially in Malaysia, Indonesia and Cambodia. These countries have the world's largest forestlands and many trees have been cut down for agriculture purposes. Not only deforestation, rapid economic growth and urbanization also contribute to climate change in

ASEAN countries (Prakash, 2018). Most of the big cities in ASEAN region are very vulnerable to floods due to misplanning in the development and construction. The graph below shows the increasing trend of CO_2 emissions in recent years. In year 2007, ASEAN countries' CO_2 emission was recorded at 776.251 metric tons and it rose up to 1139.214 metric tons in 2016 which is approximately of 363 metric tons' increment. The CO_2 emission of ASEAN countries reached its peak in 2016 although there was a slightly decrease in 2013. All these environmental degradation and economic development make it significant to find out the root cause of carbon dioxide emissions.

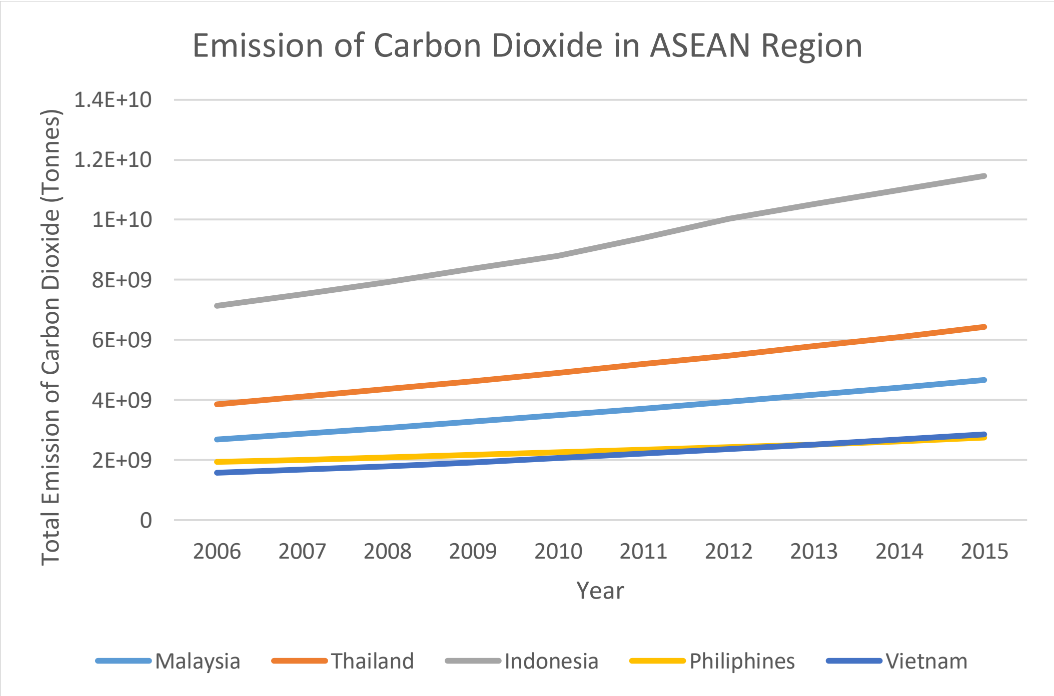


Figure 1: Emissions of Carbon Dioxide in ASEAN Region.

1.1.1 Climate Change in Malaysia

Malaysia is a developing and industrialised nation whereas it was ranked as 26th largest source of GHG in the world in year 2007 (The Star Online, 2007). Based on The Star, the CO_2 released by Malaysia in year 2004 is 177.5 million tonnes in total, which contributed 0.6% of the global total. It is sad but true that the carbon intensity in country will keep increasing as people are moving towards to a nation with increased prosperity and greater urbanisation. The higher the CO_2 intensity, the temperature of environment will become higher. According to Ho, the occurrences of extreme weather events, annual mean temperature and mean sea level are rising while rainfall shows variability due to the climate change in Malaysia. In Malaysia, there are few sectors that are suffered from climate change. For instance, biodiversity, forestry, agriculture, public health, water resources, coastal and marine resources and energy (Ho, 2018). Malaysia is a country with high urban populations living in low-elevation coastal zones. If the sea-level keep rising and oceans become warmer, the erosion here will become more serious and it will cause a huge loss in land and infrastructure and economic activities eventually (The Star Online, 2019). Hence, it will cost the government a lot for massive population relocation. Malaysia went through a serious natural disaster in December 2014, the continuous rain caused massive flood in Kelantan, Pahang, Perak and Terengganu. The damage from this flood was estimated at RM1 billion (The Star Online, 2019). In year 2013, the haze caused by Sumatra, Indonesia due to open burning of carbon-rich peatland and forests in order to clear land for agriculture had caused a large amount of carbon dioxide emitted to Malaysia as both countries are close to each other. The temperature increased as the emission of carbon dioxide rose. It leads to a decrease in GDP growth rate in this country and year 2013 was recorded the worst haze crisis year in history. As stated in The Star Online, the mean temperature of Malaysia has been rising by 0.13C to 0.24C, every 10 years between 1969 and 2014 (The Star Online, 2019). Moreover, the CO_2 emissions which have the ability to trap heat and increase temperature increased annually from year 2006 to 2017. It us shown in the graph below. The range of published evidence indicates that the net damage costs of climate change in Malaysia are likely to be significant and to rise over time.

1.1.2 Climate Change in Thailand

Thailand is considered as one of the fast-growing countries in the world especially among the ASEAN countries. According to Siring and Staporncharnchai (2019), it stated that the economic growth of Thailand was 4.1% and it was ranked third among 10 ASEAN countries. Despite having high economic growth, Thailand is now facing a problem in climate change. Based on the report by Ron Gluckman (2019), Thailand is seen to be facing a very serious problem caused by the increase in temperature. The increase in temperature has caused the rising of water levels and due to this, the capital of Thailand, Bangkok is sinking by 2 cm each year. As a result, 10 million people have been affected by this issue. Not only that, in 2011, Thailand had its biggest flood and this disaster has caused more than 800 deaths and cost an estimated $50 billion to the government. Thailand has been ranked one of the top 10 countries in the world most affected by climate change by 2017 Global Climate Index. He also mentioned that if this problem is worsened, the temperature of Thailand will rise by at least four-degree celcius in the future and there will be more serious floods in Thailand. Based on a news by YahooNews, the temperature increase in Thailand is closely linked to the emission CO_2 emission in the country and from the graph below, the CO_2 emission in Thailand is having an increasing trend since year 2007. This will definitely bring a great impact to the residents in Thailand.

1.1.3 Climate Change in Indonesia

Climate change issues in Indonesia are receiving a lot of attention due to it is the world's fifth biggest emitter of GHG, which come mainly from changes in landscape, and the effects of current global climate changes (Coca, 2018). According to World Bank, Indonesia is spewing 265 to 486 million tons of carbon dioxide from 2000 until 2017 due to plantations and agricultural activities. Besides, deforestation and forest fires also the main causes that lead to the emission of CO_2 gases in the country. Climate change in Indonesia not only has implications towards the environment of the country but it also brings the detrimental effects to people health and the country's development. Then, the climate change makes the task of development for the developing countries to become harder. Besides, shocks of climate change are already harshly felt in Indonesia, with additional climate disasters such as droughts, heat waves, and floods. Hence, if these situations continue in Indonesia, it will further threaten the development challenge of the country. Not only that, based on Leta (2019), it is about half of the islands that near to Jakarta, which is the capital of Indonesia, was located lower than normal sea level, with some neighbourhoods sinking as quick as 9 inches per year.

1.1.4 Climate Change in Philippines

The geographic location of Philippines within the Pacific "typhoon belt" and "ring of fire" makes it highly vulnerable to natural disasters. In these few years, Philippines has frequently get involved in even more violent storms. The most popular case was Typhoon Haiyan in 2013. The total GHG emissions of Philippines in 2012 were 157.6 million metric tons of carbon dioxide making up 0.33 percent of global GHG emissions (Greenhouse Gas Emissions Factsheet: Philippines, 2016). From this amount, the consumption of fuel oil and coal for electricity generation lead to 41.8 percent, contributed approximately half of the GHG emission in the country (Jalandoni, 2018). This percentage is expected to increase 3.7 percent every year. Not only that, based on the climate reality project (2016), about 20 tropical cyclones enter Philippine waters each year, with approximately eight or nine making landfall on average. Researchers and scientists believe that these are the implications of its own geographical location and development in the economy. When the climate change becomes more serious, it will lead to damage to economy, loss of likelihood, insecurity of food and even death. Moreover, according to the latest Global Climate Risk Index 2019, the Philippines has been identified as one of the ten most influenced country with a long-term climate risk index (CRI) of 19.67. Apart from that, using the data from World Bank and the graph below it can observe that Philippines' activities lead to an increasing trend of carbon emission since 2007. As a short conclusion, it can be seen that climate or weather in the Philippines has been changing or becoming worse annually. This issue has to be given concern by identifying what are the actual factors that causing the climate change to occur in Philippines.

1.1.5 Climate Change in Vietnam

Vietnam is one the South East Asia countries that is deeply affected by climate change. Global climate change causes serious consequences to Vietnam in various aspects. Vietnam recorded its highest temperature at 110 degrees in April in Huong Khe which is a district in Ha Tinh province. Doubling emission of CO_2 concentration, temperature increase is most likely to happen. According to Nguyen Vo (2019) cited by Matthew Cappucci (2019) who lives in Danang, mentioned that there are only two seasons in Vietnam which is hot and hotter. According to Phuong Hoang (2019) cited by Matthew Cappucci (2019) who stays in Hue, the emission of CO_2 causes the temperature increase which leads the temperature before sun came up is already 85 to 88 degrees. In April 2019, Vietnam still has its all-time high temperature at 43.4degree Celcius. According to a local Vietnamese newspaper, Sài Gòn Giải Phóng stated the uncomfortably weather in Vietnam starts in May will last until August. It is also known that the El Nino phenomenon will prolong from now until August or September.

According to STOA (1999), agriculture is sensitive to changes in global climate. This is a very serious issue affecting the world since the world's food production level is already under stress from the increasing population. Vietnam is one of many countries forecasted to be in the category of most affected by climate change. Global climate change will not only change the types, intensities but also frequencies of the crops and availability of water supplies. Thus, this causes the emission of CO_2 increases, temperature increases and the pattern of rainfall changes. This will lead to the fall in crop production. And below, is the proof that carbon dioxide has been emitted more and more annually despite there is only a small reduction in the emission.

1.2 Problem Statement

The concept where global climate could change unexpectedly and in a fast manner has been around for a long time. There are studies regarding ice cores which show drastic change in climate will happen soon. For instance, global temperature will change by dozen degrees or doubling or halving of precipitation rates. In the past few years, with the help of science research, human beings have improved their knowledge and awareness towards climate change. Even though some of the old problems of climate change have been allayed as time goes by, the new problems have sprung up. The problems with climate change are not only limited to big changes in temperature or rainfall in a country but it can also be extended to other systems that can exhibit abrupt the behaviour of human beings.

Climate change has negative impacts on the economy of a country. For example, there was a serious flood in Bangkok in 2011 which costed the government 50 billion USD to recover from the disaster and this flood caused more than 800 deaths. This huge amount of recovery cost could have been used for the development of the country or the welfare of the people in Thailand. Moreover, climate change also reduces the production of labour. In the research by Kjellstrom, Kovats, Lloyd, Holt & Tol (2009), they mentioned that the reduce in labour production is due to the hot weather and the humidity of the environment. They also mentioned that long hour of working under hot weather and scorching sun will cause heat stroke or even death and most of the projects are postponed due to health concern. Andrews, Quere, Kjellstrom, Lemke & Haines (2018) found out that climate change has caused changes in global temperature and humidity and this will affect living and working condition.

The impact of climate change is a major concern to ASEAN countries. Based on the report of the IPCC in 2014, the human influence on the climate system is obvious. Over the century, the greenhouse gases emissions in Southeast Asia become the highest in history. In detail, the average temperature trends in Southeast Asia have been increasing by 0.1-0.3°C per decade over the last five decades (USAID, 2010). The countries in Southeast Asia are the most vulnerable countries to the impacts of climate change. It is because Southeast Asia countries such as Malaysia, Thailand, Indonesia, Vietnam, Myanmar, Philippines and Cambodia are forecasted with the rankings by showing that seven of the twenty of these countries are prone to impacts of climate change. According to the Global Climate Risk Index 2019, Thailand and Vietnam were listed on top 10 countries most affected by extreme weather in 2017. This shows seriousness of climate change in ASEAN. Climate change will bring impacts like rising in the rate of occurrence of heat waves and even droughts, extreme rainfall, increase in sea levels, floods and tropical cyclones.

Based on Hamdan, Ab-Rahim & Sang (2018), higher financial development and economic growth in ASEAN region leads to higher production and consumption to satisfy the human needs. This is due to when the country is more developed, the demand for lands will rise and more forests will be cut for development purposes. This will highly contribute to the emission of CO_2 in the particular country.

As for macroeconomic factors such as Foreign Direct Investment (FDI), population and economic growth, studies have proven that they would lead to climate change. According to The ASEAN Post (2017), most of the countries in ASEAN are still in developing process and they would attempt to enhance their economy condition by increasing its development activities like deforestation that will contribute to environmental degradation.

As for renewable energy, Yu (2019) states that ASEAN region is lagging behind other regions in the development of Environmental, Social and Corporate Governance (ESG) infrastructure especially renewable energy. In ASEAN, Vietnam and Philippines have not really put in much effort in the development of ESG. According to Chen, Wang & Zhong (2018), renewable energy consumption and emissions of carbon dioxide has a negative relationship. So, ASEAN countries are encouraged to develop its EGS infrastructure.

As a result of aggressive development, the problem of environmental degradation is getting serious and worrying in ASEAN region. So, there is an urge and necessity to carry out a study to identify the determinants that contribute to climate change so that actions can be taken for the hope of better environment in the future.

1.3 Research Questions

There are two research questions for this study, which are:

i. What are the determinants that contribute to climate change in selected ASEAN Countries from 1996 to 2015?

ii. How does financial development act as interaction term and overall affect the climate change in the selected ASEAN countries from 1996 to 2015?

1.4 Research Objectives

1.4.1 General Objective

The primary objective of this study is to investigate the determinants of climate change in the selected ASEAN countries and the significance of financial development towards climate change.

1.4.2 Specific Objectives

The specific objectives of this research are:

i. Determine the significant factors that affect the climate change in selected ASEAN countries from 1996 to 2015.

ii. Examine the effect of financial development as an interaction term towards climate change in selected ASEAN countries from 1996 to 2015.

1.5 Significance of Study

This study is carried out to determine the factors affecting climate change in selected ASEAN countries such as Malaysia, Thailand, Indonesia, Philippines and Vietnam. The period of this study ranges from 1996 to 2015. ASEAN countries are chosen due to the seriousness of global climate change that is happening worldwide. The problem of climate change is affecting ASEAN countries deeply especially the 5 countries mentioned above. The environment situation in the 5 ASEAN countries is not a new issue as there are many articles and news discussing about the solemnity of the environment in those countries. The 5 selected ASEAN countries are considered as developing countries. The EKC hypothesis is used to explain the environmental changes in response to the country’s change in income. According to Dinda (2004), based on EKC, environment in a country changes faster in developing countries.

The EKC curve states that environmental quality of a country deteriorates at the early stages of economic development of a country. It will then improve at the later stages. At later stages, environmental changes in a country will slow down with the growth in GDP. This phenomenon can be explained by people with higher income level have higher standard towards environmental quality. EKC curve can be used to explain the environment situation in the 5 ASEAN countries.

Many of the past literatures focused on CO_2 emission, renewable energy consumption, population, economic growth and foreign direct investment (Menyah & Wolde-Rufael, 2010; Burakov & Freidin, 2017). Thus, it is necessary to do a deeper research and extend the model by adding variable such as financial development. This variable will be the gap variable of this research due to limited literatures available. Theory relating to climate change which is EKC will be explained.

In this study, financial development acts as the interaction term and it is represented by domestic credit provided by financial sector. This research would study how Financial Development causes climate change directly or indirectly. For example, higher financial development can stimulate economic growth by providing more liquidity to the companies and thus contribute to GDP. According to Sadorsky (2010), higher financial development would also contribute to the GDP of a country. Therefore, financial development can foster vigorous economic growth which will lead to the increase use of energy. As a result, there will be a greater CO_2 emission in the country. Financial development could also interact with other variables and it will be discussed in chapter 2.

1.6 Chapter Layout

There are five chapters in this study. Chapter 1 will provide an overview of the topic. Chapter 2 is a literature review on the perspective of researchers in their previous studies in relation to this study. Chapter 3 examines the methodology of conducting this study, explaining the research process, research design, and data collection method. In Chapter 4, discussions of empirical results will be included. Finally, a summary will be revealed in Chapter 5 based on the main findings of this study, along with the implications and limitations of this study, and at the end followed by the recommendations for future study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter reviews the relationship between carbon dioxide emission, population, renewable energy consumption, economic growth, foreign direct investment and financial development based on previous studies. The following section first discusses the theoretical framework that will be used in this study followed by the empirical review of independent variables and lastly the interaction between financial development and remaining independent variables will be discussed at the end of this chapter.

2.1 Theoretical Review

2.1.1 Environmental Kuznets Curve (EKC) Hypothesis

Based on the assumption of Kuznets (1955), there is an inverted-U-shaped relationship exists between income inequality and per capita income and it is recognized as Kuznets Curve. In the beginning, income inequalities and per capita income tend to increase but eventually begins to decrease followed by a turning point. In particular, there is an irregular income allocation at the initial stage of economic growth, but eventually it becomes more stable as an economy of a nation continues to grow (Kuznets, 1955).

In the 1990s, the Kuznets curve exists in another new form of existence. The quadratic relationship was used to describe the connections between environmental degradation level and per capita income, thereby this connection is recognized as the EKC hypothesis. Based on this hypothesis, CO_2 emissions rise faster than income at the infancy stage of economic growth, but it starts to slow down when the income level becomes higher. Studies from Lau, Choong, and Eng (2014) stated that when a country starts to experience the industrialisation stage, the nation would not focus on preserving the environment because they would rather focus on industrial expansions. This situation leads to higher consumptions of energy and increasing in emissions that is harmful to the environment and thus contributing to greater environment deterioration. On the other hand, during the thereafter stage of industrialisation, citizens start to give greater attentions on the issues after income rises, putting more efforts in setting regulatory institutions and system in order to counter the environmental issues (Ozturk and Al-Mulali, 2015). However, based on Wang (2012), there are mixed opinions in stating the nexus between economic growth and CO_2 emissions, which relying on the status of a nation in terms of its economic and environmental factors.

Based on Grossman and Krueger (1995), the findings showed that CO_2 emission reduces when economy of a country grows after a certain turning point, which conforms the quadratic relationship between economic growth and climate change. There are also some researchers supported the EKC hypothesis. Referring to Niu and Li (2014), the results explicit that economic expansion will give rise to better environmental quality followed by certain turning point. Ang (2007) also studied the nexus of CO_2 emissions, energy consumption and income level in France with periods of 1960 until 2000. The results revealed that energy consumption has positive impacts towards CO_2 emissions, and it is backed by the EKC phenomenon. Besides, results based on Jalil and Mahmud (2009) also indicated that there is a quadratic relationship among CO_2 emissions and income level in China over 1975 until 2005 by adopting autoregressive distributed lag model.

For illustration, based on the curve below, as an economy begins to grow, it will lead to an increase in environmental degradation. It can be seen from the EKC before the turning node (A). When an economy of a nation starts to expand, companies and businesses will tend to take this opportunity to have more investments and business activities in the country. And, these activities most likely contribute to high emissions of pollutants. In figure 1, environmental deterioration begins to make a U-turn and decline although economy of the country is still growing at node A. After the turning point A, there is a decline in environmental degradation, and eventually the Environmental Kurnetz Curve is formed. In this regard, the pressure on the environment is high during the initial stage of economic expansion and this pressure leads to greater degradation on environment quality. As time passes, the pressure become lesser and the environmental condition of a country will improve (Narayan, 2010).

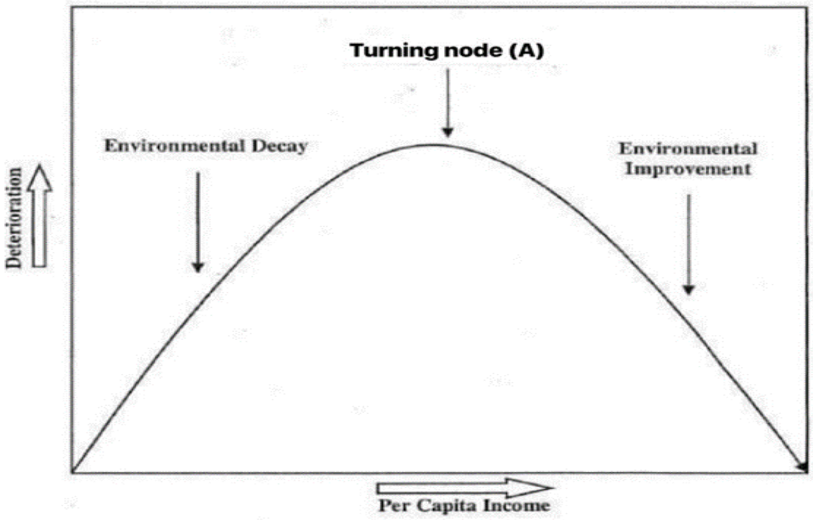


Figure 2: Environmental Kurnetz Curve

Impact = Population · Affluence · Technology (IPAT) model

In this study , IPAT model from Dietz and Rosa (1997) will be adopted as the basic model. The objective of this model is to study the effects of population size, economic expansion and technology towards CO_2 emissions.

The IPAT model comes from the idea of the standard conventional theory and is expressed as:

$CO_{2it} = \beta_0 + \beta_1 POP_{it} + \beta_2 GDP_{it} + \beta_3 RE_{it} + \varepsilon_{it}$

where CO_2 emissions per capita (CO_{2it}) is a function of population size (POP_{it}), economic growth (GDP_{it}), and renewable energy (RE_{it}).

Based on our study, three more related factors will be added which are financial development (FD_{it}) and foreign direct investments (FDI_{it}) into the model. Thus, a new model will be hypothesized by referring to the IPAT model. The hypothesized model is shown below:

$CO_{2it} = \beta_0 + \beta_1 POP_{it} + \beta_2 GDP_{it} + \beta_3 RE_{it} + \beta_4 FD_{it} + \beta_4 FDI_{it} + \varepsilon_{it}$

2.2 Empirical Review

2.2.1 Foreign Direct Investment (FDI) and Climate Change

The relationship between foreign direct investment and climate change has long been discussed and argued. Many researchers used CO_2 emission which is on type of environmental pollutants as the proxy of climate change in their research. So, foreign direct investment, CO_2 emission and climate change can be discussed together closely. The most frequently used hypothesis to describe the relationship between FDI and amount of pollutants especially CO_2 emission is the pollution haven hypothesis. Pollution haven hypothesis is based on the concept of large industrialized and multinational companies will tend to look for countries that provide the cheapest alternatives in terms of human capital, resources or even land (Jensen, 1996). Developing countries will usually provide resources at a cheap rate and tend to have less stringent environmental regulations. This will offer an opportunity for the companies to set up manufacturing factories and offices overseas especially in those cheaper cost countries. On the other hand, developed countries are keen to impose strict on businesses and society to preserve the environment. It will be an expensive cost for companies to comply all the regulations in order to have activities such as building up factories in these countries. Thus, developing countries have high possibility to suffer more environmental pollution. This means that when FDI in developing countries increases, the environmental pollution will also increase which means that the most common environmental pollutant, CO_2 emission will also increase and this will lead to climate change. There are some researches claimed that the relationship between FDI and CO_2 emission is inconclusive. Some researchers found out the relationship between FDI and CO_2 emission is positively related while some found that it is negatively related or even no significant relationship.

According to Smarzynska and Shang (2001), a research was carried out in 24 transition economies in Europe and it was found that inflows of FDI will increase CO_2 emission in host countries. This indicates that pollution haven hypothesis does exist in host countries with less stringent regulations. Researches also have been done in BRIC countries by Pao and Tsai (2001) to examine the association between CO_2 emission and FDI. The results show that when the greater the FDI inflow, the greater the amount of carbon dioxide in these countries. Developing countries such as Malaysia have also been analyzed in time series by Lee (2009), Hitam and Borhan (2012). From this research, it proves that FDI inflow and CO_2 emission has significant short run causal relationship.

On the other hand, there are also journals found indicating that negative relationship exists between FDI and carbon emission. This is supported by pollution halo hypothesis. Pollution halo hypothesis is based on the concept of multinational companies will tend to transfer modern technology and bring in best management practices when investing in the host countries. With this, company especially industrial company can reduce pollution such as CO_2 emission by exerting positive externalities (Wen, Zakaria, Shahzad and Mahmood, 2018). According to Asghari and Esfahani (2013), correlation analysis is carried out to investigate the relationship between

FDI inflow and CO_2 emission and the statistical result shows significant negatively relationship between them. This indicates the evidence for pollution halo hypothesis for the reason of FDI inflow will transfer cleaner environmental technology and enhance environmental-management practices to the host countries. When there are less environmental issue and pollutions, the host countries will not be highly vulnerable to climate change. Another research has been conducted in BRIC countries and with the statistical evidence, Tamazian, Chousa and Vadlamannati (2009) found out that frequent and high level of FDI inflow can decrease the CO_2 emissions in the host countries. The research of Lee and Brahmasrene (2013) proved that FDI and CO2 emissions is negatively related in the European Union countries.

The main reason that relationship between FDI inflow and CO_2 emission have been inconclusive because the levels of economic development and environmental regulations differ from each country (Zhang & Zhou, 2016). Thus, further research is required as there are only few researches been done in ASEAN countries. With all the empirical review from various researchers, it is expected to get a significant and positive relationship as it more suitable in developing countries' context.

2.2.2 Economic Growth and Climate Change

The relationship between climate change and the economic growth, particularly carbon dioxide has been long regarded as a very close connection. In this research, "Total GDP" was used as the proxy for economic growth. Human activities such as goods production and services are the main cause of the GDP increment and it will lead to carbon dioxide emissions eventually. In EKC applications, CO_2 emissions are the most applied emissions (Tutulmaz, 2015). EKC hypothesis postulates that economic growth is positively related to environmental degradation as the country is developing which means the country is willing to sacrifice their environment in order to improve the living standards from initial low levels. Yet, the hypothesis assumes the country will prioritize more on the environmental quality after achieving successful development. Therefore, the EKC hypothesis has an inverted U-shaped curve when pollution indicators are plotted against income per capita (Dinda, 2004).

By analyzing the data from 1970 to 2013 of 31 developing countries, Aye and Edoja (2017) found a negative relationship between carbon dioxide emissions and economic growth in low regime but positive in high regime. In this case, the EKC hypothesis is not valid. The results are supported Aslanidis and Iranz (2009) and Ahmed et al. (2017). The results suggest that when the development of a country is at its early stage, it will be characterized by service sector which emits less carbon dioxide compared to the manufacturing sector. The rise of GDP in a country tend to produce more carbon dioxide due to the expansion of manufacturing industries in that country. The country is facing economic boom period while the GDP is increasing, hence people with more income will increase dependency on electric appliances and transportations which contributes to higher consumption of energy and high pollution. On the other hand, when GDP being in low regime, it represents that the country is facing recession. During the recession, people will focus more on basic life necessities consumption and tend to reduce unnecessary consumption. In this situation, the energy intensive sectors maybe affected and hence the energy consumption and CO_2 emissions will be reduced. In other words, the countries' carbon dioxide emissions will decline against GDP in the early stages of development but increase in later stages once the GDP exceeds the threshold parameter.

Today, China is the largest developing country and has very high GDP. Hence, there are many researches had done to investigate the relationship between economic growth and CO_2 emissions in China. Based on the research of Wang, Hao and Yao (2017), GDP is used as the threshold for PSTR model and the results suggest that the influence of GDP on CO_2 emissions showed the characteristic of coincident double thresholds. Apart from that, a pull effect was exerted by GDP on the carbon dioxide emissions while the GDP is gradually rising. However, the pull effect on carbon dioxide emissions becomes weaker as the GDP keeps on rising or even exceeds the threshold parameter. This is consistent with the study of Aye and Edoja (2017).

Through the study on 69 industrial countries and 45 poor countries by using cross-sectional data, Cederborg and Snöbohm (2016) concluded that there is a positive correlation between per capita GDP and per capita CO_2 emissions. The result is different from others because the turning point for carbon dioxide emissions to start decreasing is not found when GDP is increasing to a certain level, as the result of Aye and Edoja (2017) claims.

2.2.3 Renewable Energy Consumption and Climate Change

According to Yaw (2017), the state of environment has gathered the attention of the world for more than a decade. Issues such as depletion of ozone layer, rise in global temperature and altered rainfall patterns are not new issues anymore as these issues have already happened since a few decades ago. The change in global climate is known as the world most conspicuous threat to children's health. What makes it worse is, no country is spared. All countries, no matter high-income or low-income countries are experiencing the effect of climate change. The worst scenario of climate change would be future children inheriting an untenable world which lacks vital ecological resources to support them. However, the usage of renewable energy is able to reduce the effect of climate change. Renewable energy such as solar, hydropower and biomass are commonly used in Malaysia. According to Thomas (2019), Malaysia is ASEAN's biggest solar employee. Malaysia is ranked sixth globally on the list of top solar photovoltaics (PV) employers and it is one of the ASEAN countries to make it to the top 10 besides Vietnam (The International Renewable Energy Arena (IRENA), 2019). According to IRENA (2019), Philippines is known as ASEAN's largest wind energy employer. One example to prove that renewable energy is indeed very helpful in reducing the effect of climate change is that Petroliam Nasional Berhad (Petronas) is considering investing in renewable energy such as solar, wind and biomass at a commercial scale. According to Yusof (2019), Petronas is the latest Oil and Gas Company to be interested in investing in renewable energy.

According to Chen, Wang & Zhong (2018), a study regarding the relationship between renewable energy consumption and CO_2 emission shows that there is a negative relationship between both variables. In the long run, the increasing in usage of renewable energy is able to reduce CO_2 emission. The addition of the variable, renewable energy is able to support the inverted U-shaped EKC hypothesis. This result is supported by Cheng, Ren, Wang & Cheng (2019). The results of the study indicate renewable energy is useful to reduce CO_2 emission. The study which is focusing on BRICS countries shows that renewable energy production in BRICS had increased from 19.72 terawatt-hours (TWh) to 300.67 TWh. The drastic usage of renewable energy is able to reduce the effect of CO_2 emission. Besides that, Dong, Sun & Gal (2017) mentioned that renewable energy consumption is very crucial to reduce emission of carbon dioxide and the results also showed that renewable energy will have significant negative impact on CO_2 emission.

According to Menyah & Wolde-Rufael (2010), a study is done regarding the relationship between CO_2 emissions, renewable energy consumption, nuclear consumption and real GDP shows renewable energy consumption and carbon dioxide emissions are not related to each other. The result of this study is consistent with Yaw (2017) as Yaw also finds out that renewable energy has no relationship with carbon dioxide emission. Yaw studies on regions like Washington, Oregon and Idaho. These 3 regions are the regions with relatively high renewable energy production. Thus, Yaw's results show that states with higher production of renewable energy does not necessarily able to reduce the carbon dioxide emissions.

2.2.4 Population and Climate Change

Based on Oxford Dictionary, the definition for population is the total number of habitants living in a particular area, region or country. In this research, population density of 5 countries from Southeast Asia is used to study the relationship of financial development and climate change. Based on the data from Statista.com, the population in the whole ASEAN has increased steadily for the past 10 years from an approximately 570 million to 650 million. The IPCC' Special Report on Emission Scenarios (SRES) has found out that population is one of the major factors that contribute to climate change.

York, Rosa and Dietz. (2003) found that the growth in population has positive relationship with the climate change in 142 countries. The results indicate that a 1% increase in population growth will cause 0.98% increase in ecological footprint. Ecological footprint is the demand of human beings on the nature resources like land, fuel, water and so on. Stephenson, Neyman and Mayhew (2010) mentioned that rapid growth in population is closely related to climate change as it will deplete the key resources like water, soil fertility and fossil fuel on Earth. To explain further, population growth means more consumptions and demands of natural resources and this often cause mismanagement of natural resources. Based on this research, even though developed countries have lower growth in population compared to developing countries, carbon dioxide emission in developed countries is far higher compared to developing countries. This is due to the high purchasing power of the people in developed countries which contributes to more consumption in the country. Demographic changes like size of population, urbanization and the household structure have positive impacts on carbon dioxide emission. (O'neill, Liddle, Jiang, Smith, Pachauli, Dalton, Fuchs, 2012). The emission of carbon dioxide reacts proportionately to the changes of population size. Both ageing and urbanization also have significant relationships with emission of CO_2 but it is less proportional compared to population size. Cohen (2015) mentioned that increase in population causes the increase in plant and animal foods. The production of those foods has significant impacts on atmospheric concentration on greenhouse gases which include carbon dioxide, methane and nitrous oxide.

However, population growth and CO_2 emission do not have a long-term equilibrium relationship (Knapp & Mookerjee, 1996). Based on the findings in the study, carbon dioxide emission and population are lack of co-integration which means that population is not the sole factor in causing climate change. Sulaiman & Abdul-Rahim (2018) found out that population growth does influence carbon dioxide in short run but it does not have great impacts on climate change in the long run. Vector Error Correction Model Granger Causality Approach is used to determine the short run and long run causality relationship of population growth and CO_2 emission.

2.2.5 Financial Development and Climate Change

Nowadays, there are a lot of literatures that study about CO_2 emissions and how it is caused rapid development in financial market which results in higher level of energy consumption and thus higher emissions. However, there are mixed opinions is justifying the impacts of financial development towards CO_2 emissions. In this study, the domestic credit to private sector is adopted as measurement of financial development.

Firstly, based on the previous studies by Boutabba (2014), he examines the long-run relationship between CO_2 emissions, financial development and other variables in India. The outcomes revealed that there is a long-term and positive connection between CO_2 emissions and financial development. In particular, financial expansion in India causes environmental deterioration. Based on the studies by Abbasi and Riaz (2016), they indicated that development of financial market in Pakistan has positive and significant impact towards climate change by adopting augmented VAR model. The findings revealed financial development did not relieve the environmental degradation in return it led to further environmental destruction. Not only that, Sadorsky (2010) indicated that financial development could have a positive connection with carbon dioxide emission in emerging countries like Malaysia. It is because financial development stimulates more economic activities such as foreign direct investment (FDI) in a nation which prompts investors decide to build more factories for productions.

On the other hand, by referring to Shahbaz et al (2013), the empirical results show a negative relationship whereby greater financial development tends to improve the environmental quality in Malaysia by reducing the emission of CO_2. This is because during the thereafter stage of financial expansion, the country could have enough ability to counter carbon dioxide emission by introducing some eco-green technologies and projects. Besides, based on Tamazian et al. (2009), they also revealed financial development has an inverse relationship with carbon dioxide emissions. Therefore, this relationship helped to enhance the environmental standard in the sample countries such as Russia, Brazil and India. When there is a greater financial development in a nation, the nation will have the capability to adopt financing projects at lower expenses, thereby investing in the projects that can preserve the environment. Not only that, studies by Tamazian and Rao (2010) supported the EKC hypothesis in which that financial development help to lower CO_2 emissions. It is because the greater the financial development in a country, it gives a greater motive to adopt new and advanced technologies which is environmental-friendly to the surroundings in the production processes. Moreover, according to Xiong et al. (2017), a study which was about investigating the impacts of financial development on CO_2 emissions in different province of China by using panel data. This study revealed that some provinces in China that were well-developed in its financial market could adopt advanced technologies in lowering down its carbon dioxide emissions. However, there is an inverse relationship in which financial development tends to increase the emissions of CO_2 at the areas that are less developed in China, this situation further leads to environmental degradation which is harmful to the environment.

Not only that, there are some scholars found out that financial development tends to have no relationship with CO_2 emissions. In this regard, Ozturk and Acaravci (2013) pointed out that development of financial market in Turkey has no major impact in lowering down greenhouse gases by using autoregressive distributed lags (ARDL) approach. Throughout the findings, many literatures which regarding the connection between financial development and emission of CO_2 have been found. These relationships include positive, negative and no relationship, hence this issue is still worth to be discussed among the scholars.

2.3 Interaction between Financial Development and Other Independent Variables

Financial development is the main driver of economic growth in developing countries such as Malaysia (Sadorsky, 2010). Financial development in a country can increase the financial activity like FDI, improve the efficiency in local banking services, and promote the participation of investors in stock market. Hence, financial development can help to promote the economic growth (Sadorsky 2011) and thus leads to serious environmental degradation because of higher CO_2 emissions (Zhang and Chen, 2011). Referring to Aye and Edoja (2017), financial development which attracts FDI might encourage more manufacturing activities in the country. This will later result in more serious environmental degradation and higher CO_2 emissions. According to Nasser and Gomez (2009), banking sector and stock market variables were adopted as the proxy of financial development. The results show that financial development has significant and positive relationship towards FDI for fifteen South American states from 1978-2003 by using pooled OLS.

Besides that, according to Gurley and Shaw (1967), McKinnon (1973) and Beck (2015), credit growth in financial industries can enhance the economic condition through several of activities such as enhancing the allocative efficiency of loanable funds, improving capital accumulation for investment and increasing savings. Choe and Moosa (1999) also carried out causality test to examine the relationship between the development of financial intermediaries and capital markets on economic growth in Korea. The result is that economic growth will be caused by financial development. Eita and Jordaan (2007) found that there is a stable long run relationship between financial development and economic in Botswana. Adu et al. (2013) examined the long-run growth effects of financial development in Ghana and found out that both the credit to the private sector as ratios to GDP and total domestic credit have positive impact on growth. In Sub-Saharan Africa, Ngongang (2015) employed the dynamic panel GMM technique in investigating the linkage between financial development and economic growth and the result revealed the existence of positive association between financial sector development and economic growth in the region. A developed financial system will increase the efficiency of investment and improve capital accumulation, and hence economic growth will be stimulated. Atemnkeng (2011) assessed the relationship between financial development and economic growth in Cameroon and found that in long run, financial development has a positive impact on economic growth, while a long-term causal relationship running from financial development to economic growth without a feedback system.

Arcand (2012) also found that when the ratio of private sector credit to GDP is below 100%, financial development tends to enhance economic growth. However, when that ratio exceeds 100%, further development of the financial sector tends to have negative effect on economic growth. Previous studies showed that financial development would have either positive impact or no impact on economic growth. Yet, during the financial crisis of 2007-2008, it was demonstrated that sophisticated and advanced financial systems can also negatively influence on economic growth. This is because according to Law and Singh (2014), the failure of the financial system will cause a waste of resources, a reduction in savings and an increase in speculation activities, which can lead resources misallocation and underinvestment. As a result, the economy can contribute towards increasing unemployment and poverty rates. In other words, the economy was being negatively impacted.

Apart from that, both financial development and renewable energy have positive relationship. In other words, the more developed a country is, the more the consumption of renewable energy. There is evidence showing financial development facilitates the spread of renewable clean energy. According to Coban and Topcu (2013), a study is done regarding both variables and the results show that financial development has a significant impact on the consumption of renewable energy. Xu (2012) also supported by investigating the nexus between the variables and his results show that both variables have positive significant relationship. The greater financial development will lead to greater consumption of renewable energy. Furthermore, there are also studies done by many researchers showing financial development affecting renewable energy consumption. In fact, many found out that there are bi-directional causalitys between the both variables. According to Islam, Shahbaz, Ahmed and Alam (2013), the relationship between growth of economic growth, population and energy consumption in Malaysia was tested. The result of the study shows that there is a relationship between the variables involved in the long run. This is because the demand of renewable energy depends on the financial development of a country. To be more specific, financial development leads to growth of industry, generate demand for new infrastructure and thus lead to the demand of renewable energy. Shahbaz, Hye, Tiwari & Leitão (2013) supported by showing that renewable energy consumption has a positive relationship with financial development and the study is done based in China using ARDL model.

Moreover, there are researchers who use cross-country and within-country to investigate on the relationship between financial development and renewable energy consumption. These studies prove the hypothesis of a 'feedback effect' and found bi-directional causality. According to Rafindadi and Ozturk (2017), a study is done based in Germany and the existence of bidirectional causal effects between renewable energy consumption and financial development was identified.

Furthermore, financial development is closely related to population. The relationship between financial development and population is expected to be positive. Based on the study by Durusu-Ciftci, Ispir and Yetkiner (2017), it is proven that financial development is positively related with population growth. Herwartz and Walle (2014) found that financial development is the main contribution to the economy growth which includes population growth. Improved financial development can stimulate the economy of the country and this will increase the job opportunity. With more job opportunity, the average income of the country will increase and thus population will increase as well. Bongini, Iwanicz-Drozdowska, Smaga and Witkowski (2017) found that bank credit is an important source of population growth in 74 countries from Central, Eastern, and South-

Eastern European. Higher credit to private sector by the banks means more financial development in the country. Private companies obtain credit or loans from the banks and the money will be used to develop the company. This will bring more jobs to the people in the country. Bongini et. al (2017) also found that positive relationship is more evident in low to middle-income countries. Bank credits can help companies to growth in long run capital accumulation and productivity improvement. According to Ismail and Masih (2015), financial development is said to contribute to population growth in Indonesia. Financial development is able to increase population in the long run.

On the other hand, there are researches showing that foreign direct investment (FDI) can affect the financial development of a country. According to Alfaro, Chanda, Kalemli-Ozcan and Sayek (2010), FDI can promote financial development of a country. FDI can promote financial development by directly promoting the scale of finance. Investments from foreign companies or countries will lead to the inflow of currency into the host country. As a result, this will develop the country's financial sector and thus, promoting the financial development of the host country. Iamsiraroj (2016) also mentioned that FDI acting as one of the most crucial sources of capital inflow, has a positive relationship with a country's economic development. When FDI in a country increase, it brings in advanced and sophisticated technologies into the country. Not only that, it will also bring in management expertise and thus boosting the financial development of the country. Aibai, Huang, Luo and Peng (2019) supported by showing that with a 1% increase in FDI, the host country's financial development increases by about 0.1%. The results also show that FDI promotes financial development in countries with high quality institutions, low corruption cases and less ethnic conflict. With the injection of FDI into a country's financial sector, this can benefit the country's financial development in terms of its quality and quantity.

CHAPTER 3: METHODOLOGY OF STUDY

3.0 Introduction

In this chapter, data sources, data description, econometric framework and the empirical testing procedures in this study will be introduced.

Data type used in this study is secondary data and it was retrieved from reliable sources, such as "Our World in Data", "World Bank" and "OECD Data" to ensure the results obtained are efficient and unbiased. Secondly, the description of data describes the data by explaining the definition of each variables and show the proxy used for each variable and the measurement used in this study.

Besides, the econometric framework was designed based on the literature review in Chapter two. In this part, there is one linear regression model which is known as Model 1. It is the base model that shows the relationship between the dependent variable and explanatory variables.

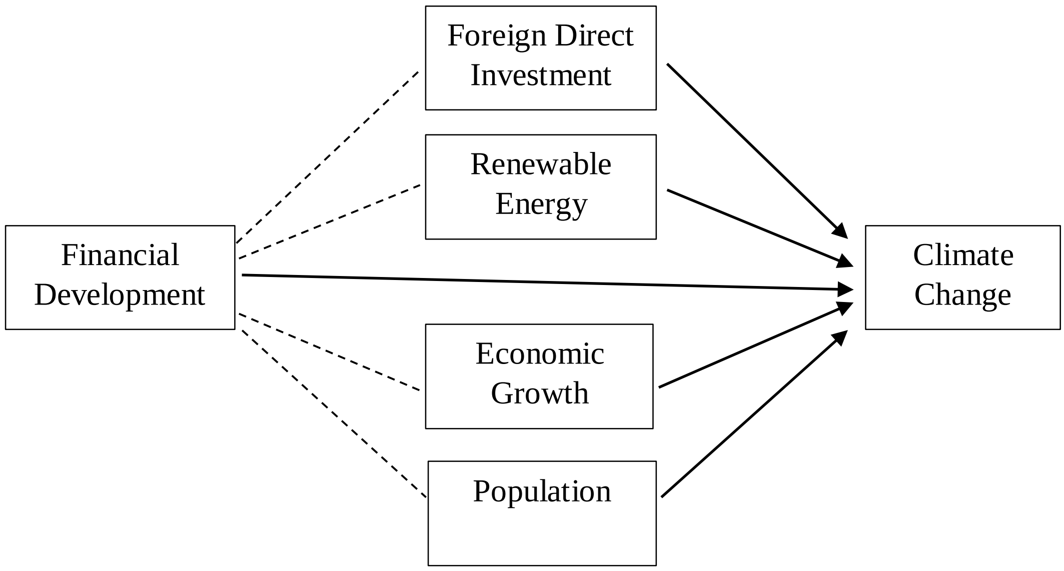
Apart from that, the overview of tests will be discussed in this chapter and they will be used to examine the empirical results. Panel Unit Root test will be used for conducting the preliminary analysis. This test shows the stationary conditions of the variables. Therefore, Levin-Lin-Chu (LLC) test is chosen to check the stationary of each variables.

Last but not least, the estimation method will include three types of panel data model such as the Pooled OLS (POLS), Fixed Effect Model (FEM) and Random Effect Model (REM). Likelihood Ratio Test, Lagrange Multiplier Test and

Hausman Test will be conducted to determine the appropriateness of these three models. Diagnostic checking will also be carried out to detect econometric problems in the model. It plays a very important part in this study so that unbiased and efficient empirical results can be obtained.

3.1 Research Framework

Figure 3: Research Framework



This research framework shows how the independent variables, Foreign Direct Investment, Renewable Energy, Economic Growth, Population and Financial Development affect climate change in the selected countries in ASEAN region. Financial Development acts as the interaction term in the framework and it affects other independent variables indirectly.

3.2 Econometric Framework

3.2.1 Base Model

$CO_{2\,it} = \beta_0 + \beta_1 RE_{it} + \beta_2 EG_{it} + \beta_3 POP_{it} + \varepsilon_{it}$

Where,

CO_2 = Emission of carbon dioxide (tonnes)

RE = Consumption of Renewable energy (% of consumption of total energy)

EG = Economic Growth (Gross Domestic Product)

POP = Population (population density)

β_0 = Y-intercept

$_i$ = Malaysia, Thailand, Indonesia, Philippines, Vietnam

$_t$ = Year 1996, 1997, 1998, …, 2015

ε_{it} = Error term

The base model of this research was extracted from the study of Dietz and Rosa (1997). This model studies the relationship between the CO_2 emission and population, economic growth and renewable energy consumption. All the variables are converted into natural logarithm form. A series of cross-sectional dependence and slope homogeneity are adopted in this research. The results show that economic growth and population are positively significant on CO_2 emission for all the five regions, at both the global and regional status.

3.2.2 Linear Regression Analysis (Model 1)

$$\ln CO_{2\,it} = \beta_0 + \beta_1 \ln RE_{it} + \beta_2 \ln EG_{it} + \beta_3 \ln POP_{it} + \beta_4 \ln (FDI^2)_{it} + \varepsilon_{it}$$

Where,

CO_2 = Emissions of Carbon Dioxide (Tonnes)

RE = Consumption of Renewable Energy (% of consumption of total energy)

EG= Economic Growth (Gross Domestic Product)

POP = Population (population density)

FDI = Foreign Direct Investment (net inflow of FDI)

β_0= Y-intercept

$_i$ = Malaysia, Thailand, Indonesia, Philippines, Vietnam

$_t$ = Year 1996, 1997, 1998, …, 2015

ε_{it} = error term

For Model 1, one additional variable, FDI has been included to the equation or model estimation. All the dependent and explanatory variables are converted into natural logarithm form. “Total Net Inflow of FDI” has been used as the proxy for this independent variable. The data of foreign direct investment have been squared to make sure that it enables the transformation of logarithm form that will standardize the changes of data to a comparable range. The reason why this variable was added into the model is because FDI has been proven to be closely linked to Financial Development. The contribution of FDI to the carbon dioxide emission in the 5 ASEAN countries was also intended to be investigated in this study.

3.2.3 Linear Regression Analysis (Model 2)

$$\ln CO_{2\,it} = \beta_0 + \beta_1 \ln RE_{it} + \beta_2 \ln EG_{it} + \beta_3 \ln POP_{it} + \beta_4 \ln(FD)_{it} + \varepsilon_{it}$$

Where,

CO_2 = Emissions of Carbon Dioxide (tonnes)

RE = Consumption of Renewable Energy (% of consumption of total energy)

EG = Economic Growth (Gross Domestic Product)

POP = Population (population density)

FD = Financial Development (domestic credit provided by financial sectors)

β_0= Y-intercept

$_i$ = Malaysia, Thailand, Indonesia, Philippines, Vietnam

$_t$ = Year 1996, 2007, …, 2015

ε_{it} = Error term

In Model 2, financial development has been included to investigate its relationship on CO_2 emission in ASEAN-5 countries. The proxy for this variable is domestic credit provided by financial sectors. This variable acts as the interaction term in the following model to determine whether it will have indirect relationship on CO_2 emission. This model consists of four independent variables which are population, consumption of renewable energy, economic growth and financial development and all the variables are converted into natural logarithm form.

3.2.4 Linear Regression Analysis (Model 3)

$lnCO_{2\,it} = \beta_0 + \beta_1 \ln (RE_{it}*FD_{it}) + \beta_2 \ln (EG_{it}*FD_{it}) + \beta_3 \ln (POP_{it}*FD_{it}) + \beta_4 \ln (FDI^2_{it}*FD_{it}) + \varepsilon_{it}$

Where,

CO_2 = Emissions of Carbon Dioxide (tonnes)

RE*FD = Consumption of Renewable Energy multiply with Financial Development

EG*FD = Economic Growth multiply with Financial Development

POP*FD = Population multiply with Financial Development

FDI^2*FD = Foreign Direct Investment multiply with Financial Development

β_0 = Y-intercept

$_i$ = Malaysia, Thailand, Indonesia, Philippines, Vietnam

$_t$ = Year 1996, 2007, …, 2015

ε_{it} = Error Term

The interaction model, Model 3 shows how financial development interacts with the other 4 independent variables, renewable energy consumption, economic growth, population and foreign direct investment. In this model, all the dependent and explanatory variables are converted into natural logarithm form and the data of foreign direct investment have been squared to make sure that it enables the transformation of logarithm form that will standardize the changes of data to a comparable range. The purpose of this model is to study how financial development indirectly affects other variables and eventually contributes to the changes in emission of CO_2. In other to study the interaction of FD with other variables, each variable is multiplied with financial development.

3.3 Source of Data

In this study, climate change represents the variable that wanted to be studied and it is proxied by the CO_2 emission. On the other hand, the selected independent variables included financial development, FDI, economic growth, consumption of renewable energy as well as population. The sources and unit measurements of data will be summarised in the table 3.3.1. Annual data from year 1996 to 2015 are collected from 5 ASEAN countries which are Malaysia, Philippines, Vietnam, Indonesia as well as Thailand. Also, the type of data used is panel data which is the combination of time series and cross-sectional data.

Table 3.3.1 Proxy, Unit Measurement and Sources of Data

Variable	Proxy	Unit Measurements	Sources	Expected Sign
Climate change	CO_2 Emissions	Tonnes	Our world in data	-
Foreign Direct Investment	Net Inflow of FDI	Current USD	World Bank	+ve
Economic Growth	Gross Domestic Product (GDP)	Current USD	World Bank	+ve
Financial Development	Domestic Credit by Financial Sectors	%	World Bank	+ve
Renewable Energy Consumption	% of total energy consumption	%	OECD	-ve
Population	Population Density	People per Sq. km of Land Area	World Bank	+ve

3.4 Data Description

Two explanatory variables have been added into the Environmental Kuznets Curve which are foreign direct investment and financial development. Thereby, there are total of 5 independent variables in this study. There will be some brief explanations about the variables included in this study.

3.4.1 Climate Change

Climate change is an environmental warning which is an effect of the formation and increment of greenhouse gases (GHG). Greenhouse gases have the ability to trap and absorb infrared radiation emitted from Earth and reradiating it back to Earth's surface. The major constitution of GHG is CO_2 and this type of gas is primarily released from combustion of fossils fuels such as coal. The proxy for climate change is total carbon dioxide emission and it is usually measured in tonnes.

3.4.2 Foreign Direct Investment

According to International Monetary Fund, an investment will be recognized as FDI when an individual or business have an ownership of 10 percent or more of a foreign company. It allows the investors to have a controlling interest and right to influence the company's management, policies and operations. FDI is essential for developing countries because the local corporations have to obtain their fund multinational to expand their international transactions. The proxy for FDI is total net inflow and the unit measurement for this proxy is Current USD.

3.4.3 Economic growth

Economic growth is explained as increment in the production of economic goods and services that are officially acknowledged by a country compared from one period to the past. It also can be explained as the increase in inflation-adjusted market value of the goods and services. Total gross domestic product (GDP) is the major symptom for economy health of a country. Unit measurement of this proxy is Current USD.

3.4.4 Financial Development

Financial development means development in financial markets, institution as wellas instruments. In most of the researches, domestic credit provided by financial sector was used to represent financial sector when assessing its impacts on climate change and the unit of measurement for this model is current USD. Domestic credit provided by financial sectors refers financial resources such as loans, purchasing of non-equity securities and trade credits and other account receivable offered by financial sectors that stimulate for a claim in repayment.

3.4.5 Consumption of Renewable Energy

Renewable energy is energy generated from renewable resources including sunlight, rain, wind, waves, geothermal heat and many other types of biomass. This kind of energy will not be depleted and will regularly renewed (Daniel Ciolkosz, 2009). The proxy for this variable is the total renewable energy consumption and the unit measurement for this proxy is tonnes oil equivalent.

3.4.6 Population

Population is referred as the total collection of humans in a particular region (Kenton, 2019). It is estimated that higher population will contribute more to carbon dioxide emissions in the country. Population adopts the proxy of population density of the country and its unit measurement is the number of people per square km of land area.

3.5 Empirical Testing Procedures

3.5.1 Panel Unit Root Test

Unit Root Test is adopted to examine the existence of unit root in panel data sets. Panel data is said to be stationary when it is independent from time changes. One of the major factors contributing to non-stationarity is unit root. If the data set consists of unit root, it tends to exhibit a systematic pattern that is unpredictable. In this test, null hypothesis will be generally defined as unit root presented in the data set while the alternative hypothesis will be the data set is stationary. Based on Nell and Zimmermann (2011), this test offers coverages to infinity which is appropriate for the researchers who keen to examine non-stationarity panel variable and study asymptotic behaviour of estimators. Levin, Lin and Chu (LLC) test (2002) will be used to examine the common unit root in this study. Stationarity of variables need to be confirmed so that it obeys the classical linear regression model assumptions which require constant variance in the econometric model. With constant variances, Ordinary Least Square (OLS) method can be utilised to obtain precise result. The estimators will be efficient. This will not only strengthen the validity of hypothesis testing, but the t-statistic and p-value in the model will be reliable.

General regression model applied in panel unit root test is as below:

$$\Delta yt-1 = \alpha 0 + \gamma yt-1 + u\text{t}$$

3.5.1.1 Levin-Lin-Chu Test

LLC test is used to investigate stationarity of panel data. Based on Levin-Lin-Chu (2002), heterogeneity of individual deterministic impacts and heterogeneous serial correlation structure of error terms are allowed by making an assumption of same first order autoregressive coefficients. The null hypothesis for this LLC test is the data set contains non-stationarity while the alternative hypothesis is the data set is stationary. LLC test is modelled by using the following method.

The LLC test is based on ADF regression model.

$$\Delta y_i = \alpha_{0i} + x_{0i} + x_{1i}t + \varepsilon_{it}$$

Where, i = 1,2,3, …, N

t = 1,2,3, …, T

3.5.2 Pooled Ordinary Least Square (POLS)

Pooled model a model with different individuals gathered together without assuming individual characteristics. The model below shows the regression model of POLS. The estimation of POLS is one of the OLS method that applied on panel data. Thus, all individual and specific characteristics are excluded, and POLS contains of few assumptions. It can be assumed that the regression coefficient is indifferences among countries while pooling all observations together. Normally distribution of error term, zero mean with constant variance of error term are the assumptions of POLS. The last assumption is the exogeneity of all explanatory variables.

$$Y_{it} = \beta_0 + \beta_1(X_{it,1}) + \beta_2(X_{it,2}) + \cdots + \beta_k(X_{it,k}) + \mu_{it}$$

Where,

Y_{it} = Dependent variable

$X_{it,k}$ = Independent variables; *i* = country; *t* = time period; k = 1, 2, 3, …

β_0 = Slope intercept

β_k = Coefficient for independent variables; k = 1, 2, 3, …

μ_{it} = Idiosyncratic error

3.5.3 Fixed Effects Model (FEM)

FEM is a regression model where the estimators are constant and there are non-random characteristics. The term 'fixed effects' in the FEM is defined as the intercepts might be different across the individuals, but each of intercepts do not vary in its effects as time passes and it is not correlated to the characteristics of other subjects. This situation is known as time invariant. The error term of each unique individual must not be associated, otherwise the results will be considered as inappropriate. Referring to Mushtaq and Siddiqui (2017), the characteristics of variables that fluctuate occasionally can be examined through FEM. In order to conduct FEM, the model need to fulfil the assumptions of CLRM. However, the side effects of using FEM, is it will eliminate many degrees of freedom which will result in unstable estimation results. Besides, another side effect is that it cannot be used to determine the time-invariant that is resulted from the dependent variable in the model (Torres-Reyna, 2007). Fixed effects model is formed in the following way:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_x X_{xit} + \mu_{it}$$

Where:

Y_{it} = Dependent Variable

X_{xit} = time variant independent variables, x=1,2, 3, …

α_i = unobserved time invariant individual effect

μ_{it}= error term

3.5.4 Random Effects Model (REM)

REM is defined as error component model and it has become the most usual techniques for synthesizing a set of effect sizes. It permits a model to have its own fixed intercept value. This model assumes that intercept value is randomly drawn from the population. REM assumes that all the explanatory variables are time-invariant. Furthermore, REM is normally adopted for the estimation of dummy variables like gender, preference, age and so on by implementing Least Square Dummy Variable model. REM is able to capture the difference of true effect size. Individual characteristic is assumed to have no correlation with regressor as well as estimate error variance specific to group. Therefore, this explains the reason why REM is preferable over FEM providing the assumption holds. REM is formed in the following way:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_x X_{xit} + [\mu_i + \mu_{it}]$$

Where:

Y_{it} = Dependent Variable

X_{xit} = Explanatory variables, x=1,2, 3, …

β_0 = Slope intercept

β_x = Coefficient for explanatory variables, x=1,2,3, …

μ_i = Unobserved cross-sectional effect

μ_{it} = Idiosyncratic error

3.5.5 Likelihood Ratio (LR) test

LR test was an idea from Neyman and Pearson in 1928. Lehmann (2006) claimed that this test can be adopted to compare the maximum likelihood by using hypothesis testing. Then, this test is also being used to make a comparison on the goodness of fit of POLS model and FEM model. For this test, the null hypothesis is that POLS is better than FEM while the alternative hypothesis is FEM is better than POLS.

LR test has a decision rule which is rejection of null hypothesis if the p-value of the estimated model is less than the significance level of 1%, 5% and 10%. Else, it will not be rejected. Another situation is when the test statistics of t estimated model is greater than the critical value of model. Therefore, the pooled OLS is preferable if there is no rejection of null hypothesis.

3.5.6 Hausman Specification Test

Hausman Specification Test was intended by James Durbin, De-Min Wu, and Jerry A. Hausman. Originally, it is used to examine the consistency of an estimator when making comparison with a less efficient estimator which is already proved to be consistent. Also, it is applied to examine and capture endogenous regressor in a regression model. Ordinary Least Square (OLS) method assumes that endogenous regressor and error term should not have correlation (Hausman, 1978). When a model consists of endogenous regressors, it will cause the hypothesis testing to be invalid, t-statistic and p-value tend to misleading and thus providing spurious results. By getting the concept of Hausman Specification Test, it will be applied to determine the appropriateness of model between FEM and REM in this research. The null hypothesis will be REM is preferable than FEM while the alternative hypothesis will be FEM is better than REM. Rejection of null hypothesis if the p-value of the estimated model is less than the significance level of 1%, 5% and 10% else there is no rejection null hypothesis. The general formula applied in Hausman Specification Test is shown as below. This method will only be applied in this study after some modifications.

$H= (\beta FEM-\beta' REM)\ [(\beta' FEM) - Var\ (\beta' REM)] -1\ (\beta' FEM-\beta' FEM)$

3.5.7 Breusch-Pagan Lagrange Multiplier (BP-LM) Test

LM test used to investigate hypotheses about estimators in a likelihood framework. The hypothesis under test is disclosed as one or more constraints on the values of estimators. In order to conduct an LM test only estimation of the estimators subject to the restrictions is needed. One of the most common LM test is BP-LM test and it will be adopted in this study. This test enables the researchers to determine whether a random effects regression or ordinary least squares is preferable to carry out the following hypothesis testing. The variance across the variables are said to be zero under null hypothesis. In this test, the null hypothesis will be POLS is preferable than REM while the alternative hypothesis will be REM is better than POLS.

3.6 Diagnostic Checking

There are few important tests to be carry out to verify the specification of this study's model, including Normality Test, Variance Inflation Factor Test, Breusch-Godfrey Serial Correlation LM test and Breusch-Pagan-Godfrey Test.

3.6.1 Multicollinearity

Multicollinearity problem happens when there is more than one explanatory variable is found to have high correlation with each other among the regression model. The reasons behind this circumstance are improper use of dummy variables and unrepresentative of data (Vatcheva, Lee, McCormick & Rahbar, 2016). If multicollinearity issue exists in a regression model, it will find difficult to determine which explanatory variables are affecting the dependent variable. The symptoms of multicollinearity are high standard errors, low significance level and extremely high value of R^2. However, the regression model is still considered Best Linear Unbiased Estimators (BLUE), as long as the model does not violate the CLRM assumptions.

There are several methods to determine the problem of multicollinearity in a regression model. Firstly, pair-wise correlation coefficient (covariance matrix) is used to capture the problem in which high value of pair-wise correlation coefficient signals high chances of multicollinearity problem occurs in the model. A model is said to have multicollinearity problem when the pair-wise correlation coefficient is equal or more than 0.8 between two variables (Yu, Jiang & Land, 2015). Not only that, Variance Inflation Factor (VIF) can also be adopted to discover the multicollinearity issue in a model. VIF is used to quantify the amount of variance between one estimator and another estimator in a regression model. If the VIF of a regression model is discovered to be too high (more than 10), it is not a good sign since the model is suspected to have multicollinearity issue (Studenmund, 2014). Below is the formulas of VIF:

$$\text{VIF} = \frac{1}{\left(1-R_J^2\right)}$$

3.6.2 Normality Test

Based on assumption of Classical Linear Regression Model (CLRM), error term in linear model must be verified to be normally distributed before continue with any other data analysis. This is to prevent inconsistency and biasness of data. By referring to Jarque and Bera (1987), they introduced Jarque-Bera (JB) test to determine the normality of data. The test applies on OLS estimator and the sample of skewness (S) and kurtosis (K). This test is one of the chi-square tests and its degree of freedom is always 2. Below shows the formula for JB test'

$$JB = \frac{N}{6}\left(S^2 + \frac{(K-3)^2}{24}\right)$$

Hypothesis testing:

H_0: The error term is normally distributed.

H_1: There error term in not normally distributed.

The decision rule is that there will be rejection of null hypothesis if the probability is found to be lower than 1%, 5% and 10% of significance level respectively. Else, there is no null hypothesis. In particular, p-value must be larger than all significance levels in order to ensure normally distribution of error term.

3.6.3 Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey was proposed by Trevor S. Breusch and Leslie G. Godfrey and it is applied to test for the presence of autocorrelation in the regression model. It is meant to be implemented to a set of regression residuals under the assumption of weakly exogenous, or predetermined, regressors. The null hypothesis and alternative hypothesis for Breusch-Godfrey Serial Correlation LM test are as follows.

Null hypothesis: H_0: There is no autocorrelation in the model.

Alternative hypothesis: H_1: There is autocorrelation in the model.

The decision rule is that there will be rejection of null hypothesis if the p-value of the estimated model is lower than the respective significance level of 1%, 5% and 10%. Else, there is no rejection of null hypothesis.

3.6.4 Breusch-Pagan-Godfrey Test

Breusch-Pagan-Godfrey test was proposed by Trevor Breusch and Adrian Pagan in 1979. It is applied to capture heteroscedasticity in a regression model. Heteroscedasticity is a circumstance where the variability of a variable is unequal across the range of values of a second variable that estimates it. In a simpler word, it violates the assumption of ordinary least square (OLS) that all residuals must have the constant variance. A model with heteroscedasticity problem would have less precise coefficients for the variables. Below is the null and alternative hypothesis for Breusch-Pagan-Godfrey test:

Null hypothesis: H_0: There is no heteroscedasticity in the model.

Alternative hypothesis :H_1: There is heteroscedasticity in the model.

The decision rule is there is no rejection of null hypothesis if the p-value of the estimated model is lower than the significance level of 1%, 5% and 10% respectively. Else, there is no rejection of null hypothesis.

CHAPTER 4: ANALYSIS OF DATA

4.0 Introduction

Chapter 4 discusses about the empirical results acquired from regression analysis. The structure of this chapter includes section 4.1 which shows the results of panel unit root test, followed by section 4.2 and 4.3 that revealed the panel data model estimation and model comparison outcomes. Lastly, section 4.4 discusses about the results of diagnostic tests.

4.1 Panel Unit Root Test (Levin, Lin and Chu Test)

The analysis conducts panel unit root test for all variables using Levin, Lin and Chu Test. Rejection of null hypothesis indicates that the variable is non-stationary. Table 4.1.1 summarizes the outcome of Levin, Lin and Chu Test at level for all variables in Model 1 and Model 2 and Model 3.

Table 4.1.1:

Levin, Lin and Chu Test for Model 1, Model 2 and Model 3

Model	**(1)**		**(2)**		**(3)**	
Variables	Individual Effects, Level Form	Individual Effects, Individual Linear Trends, Level Form	Individual Effects, Level Form	Individual Effects, Individual Linear Trends, Level Form	Individual Effects, Level Form	Individual Effects, Individual Linear Trends, Level Form
$LNCO_2$	-2.6456*** (0.004)	-1.6643** (0.0480)	-2.6456*** (0.0041)	-1.6643** (0.0480)	-2.6456*** (0.0041)	-1.6643** (0.0480)
LNFDI	-1.4853** (0.0687)	-4.8942*** (0.0000)				

LNFD			-3.3031*** (0.0005)	0.3540 (0.6383)		
LNPOP	-3.5486*** (0.0002)	-6.7834*** (0.0000)	-3.5486*** (0.0002)	-6.7834*** (0.0000)		
LNGDP	-3.2068*** (0.0007)	-2.5132*** (0.0060)	-3.2068*** (0.0007)	-2.5132*** (0.0060)		
LNRE	-1.3775* (0.0842)	0.4880 (0.6872)	-1.3775* (0.0842)	0.4880 (0.6872)		
LNFDI_FD					-1.1430 (0.1265)	-4.8660*** (0.0000)
LNPOP_FD					-2.5417*** (0.0055)	0.4140 (0.6606)
LNGDP_FD					-1.7947** (0.0364)	-1.7308** (0.0417)
LNRE_FD					-4.3406*** (0.0000)	0.3556 (0.6389)

*Notes: The asterisks *, **, *** indicate rejection of null hypothesis at 10%, 5% and 1 % significance level, respectively. P-value in parentheses.*

Based on Table 4.1.1, for Model 1, carbon dioxide emission, population and GDP are stationary at 1% significance level, while FDI is stationary at 5% and renewable energy consumption is stationary at 10% level of significance for individual effects at level form. Hence, it is believed that the variables are stationary and they can be used to conduct the following analysis on determining the relationships between variables. For Model 2, the variables such as carbon dioxide emission, financial development, population and GDP are stationary at 1% of significance level while renewable energy consumption is stationary at 10% of significance level respectively for individual effects at level form. On the other hand, all variables in Model 3 except FDI interacts with FD are stationary at the level of significance, 1% and 5% for individual effects at level form. However, FDI interacts with FD is stationary at 1% level of significance for individual effect of linear trend at level form. So, this result indicates that the variables do not suffer from non-stationarity problem can be used to conduct the analysis.

4.2 Panel Data Model Estimation

This study employs three panel data model estimations to estimate the individual effect and time series effect on every variable including CO_2 emission and the five independent variables, Population, Foreign Direct Investment, Renewable Energy Consumption, Economic Growth and Financial Development. The interaction between financial development and other independent variables towards CO_2 emissions will also be modeled in these three types of model. The three panel data estimation models are POLS, FEM and REM. Table 4.2.1, Table 4.2.2 and Table 4.2.3 indicate the three different panel data estimation models for Model 1, Model 2 and Model 3 respectively.

Table 4.2.1:

Panel Data Model for Model 1

	POLS	FEM	REM
C	3.4422***	2.0304***	3.4422***
	(0.2964)	(0.4877)	(0.2050)
LNFDI	-0.0024	-0.0139	-0.0024
	(0.0101)	(0.0085)	(0.0070)
LNPOP	-0.1953***	1.7384***	-0.1953***
	(0.0352)	(0.3014)	(0.0244)
LNGDP	0.5676***	0.3441***	0.5676***
	(0.0293)	(0.0488)	(0.0202)
LNRE	0.0633***	0.0062***	0.0633***
	(0.0058)	(0.0952)	(0.0040)
R-squared	0.9327	0.9691	0.9327
Adjusted R-squared	0.9299	0.9664	0.9299

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively. Standard error in parentheses.*

Table 4.2.1 shows the panel data model estimation results for Model 1. Based on the table, the R-square for Pooled Ordinary Least Squares Method (POLS) model is 0.9327. This means that 93.27% of the variation in CO_2 emission is explained by the variation in the independent variables. Besides that, there are three explanatory variables, GDP, population and renewable energy consumption which are significant at 1% level of significance. On the other hand, FDI is insignificant at all level of significance.

According to the Table 4.2.1, it shows that the R-squared for Fixed Effect Model (FEM) is 0.9691. This indicates that 96.91% of the variation in CO2 emission can be explained by the variation in the explanatory variables. There are three explanatory variables, GDP, population and renewable energy consumption which are significant at 1% level of significance. However, FDI is insignificant at all level of significance.

As for Random Effect Model (REM), the R-squared for Model 1 is 0.9327 which indicates that 93.27% of variation in carbon dioxide emission is explained by the variation in the independent variables. By using the REM method, the results achieved is similar to the results of POLS method and FEM method. GDP, population and renewable energy consumption are significant at 1% level of significance. However, FDI is found also to be insignificant at all level of significance.

Table 4.2.2:

Panel Data Model for Model 2

	POLS	FEM	REM
C	3.3526***	2.0203***	3.3526***
	(0.3037)	(0.6481)	(0.2146)
LNFD	0.0638	0.0075	0.0638*
	(0.0542)	(0.0530)	(0.0383)
LNPOP	-0.1644***	1.8588***	-0.1644***
	(0.0436)	(0.3458)	(0.0308)
LNGDP	0.4986***	0.2967***	0.5534***

	(0.0251)	(0.0456)	(0.0178)
LNRE	0.2323***	0.0043	0.0709***
	(0.0083)	(0.1266)	(0.0059)
R-squared	0.9336	0.9683	0.9336
Adjusted R-squared	0.9308	0.9655	0.9308

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively. Standard error in parentheses.*

Table 4.2.2 depicts the results for POLS model estimation. Based on the table, Model 2 has a R-squared of 0.9336 which indicates that the 93.36% of the total variation in CO_2 emission is explained by the total variation in the independent variables. From the results, it shows that all the explanatory variables are significant at 1% level of significance except financial development.

Table 4.2.2 also indicates the results for FEM model estimation. Based on the table, Model 2 has a R-squared of 0.9683 which means that there is 96.83% of the total variation in CO_2 emission can be explained by the total variation in the explanatory variables. The independent variables like population, GDP and renewable energy consumption are all significant at 1% of significance level except financial development which does not significant at all level of significance.

By referring to REM in the same table, Model 2 has a R-squared of 0.9336 and this denotes that 93.36% of total variation in CO_2 emission can be explained by the total variation in the independent variables. All explanatory variables are significant at 1% of significance level except financial development is significant at 10% of significance level.

Table 4.2.3:

Panel Data Model for Model 3

	POLS	FEM	REM
C	4.5525***	5.2572***	4.5525***
	(0.3118)	(0.3514)	(0.2051)
LNFDI_FD	0.0001	-0.01988**	0.0001

	(0.0124)	(0.0099)	(0.0081)
LNGDP_FD	0.4223***	0.5600***	0.4223***
	(0.0285)	(0.0441)	(0.0187)
LNPOP_FD	-0.2495***	-0.1747	-0.2495***
	(0.0519)	(0.1160)	(0.0341)
LNRE_FD	0.1003***	-0.5150***	0.1003***
	(0.0089)	(0.0995)	(0.0059)
R-squared	0.8985	0.9580	0.8985
Adjusted R-squared	0.8943	0.9543	0.8943

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively. Standard error in parentheses.*

Based on Table 4.2.3, the R-square for Model 1 is 0.8985. This means that 89.85% of the variation in CO_2 emission is explained by the variation in the independent variables. Besides that, there are three explanatory variables which are GDP, population and renewable energy consumption are significant affecting CO_2 emission at 1% level of significance when interacting with financial development. On the other hand, the interaction between financial development and foreign direct investment (FDI) is insignificantly affecting CO_2 emission at all level of significance.

According to the same table, the R squared for Fixed Effect Model is 0.9580. This indicates that 95.80% of the variation in CO_2 emission can be explained by the variation in the explanatory variables. There are two explanatory variables, GDP and renewable energy consumption are significant affecting CO_2 emission at 1% level of significance when interacting with financial development. Apart from that, FDI is significant at 5% level of significance when interacting with financial development. Only population is insignificant at all level of significance.

As for Random Effect Model (REM), the R-squared is 0.8986 which indicates that 89.86% of variation in carbon dioxide emission is explained by the variation in the independent variables. By using the REM, GDP, population and renewable energy consumption are significant at 1% level of significance while FDI is insignificant at all level of significance when interacting with financial development.

4.3 Model Comparison

For model comparison, Likelihood-Ratio (LR) test, Hausman test and Lagrange Multiplier (LM) test are used to determine the most appropriate model for this study. Three tests were used to compare the POLS model, FEM and REM in order to determine the best model for this estimate. In order to compare between POLS and FEM, Likelihood-Ratio (LR) Test was used. In addition, Hausman Test was used to make comparison between FEM and REM while Lagrange Multiplier (LM) Test was used to determine the better model between POLS and REM. Table 4.3.1 explains the results for Model 1.

Table 4.3.1:

Model Comparison for Model 1

	Likelihood-Ratio (LR) test	Lagrange Multiplier (LM) test	Hausman test
Test Statistic	78.0173***	51.6816***	107.5483***
Decision Making	Null hypothesis is rejected	Null hypothesis is rejected	Null hypothesis is rejected
Conclusion	FEM is better than POLS	REM is better than POLS	FEM is better than REM

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively.*

Based on the first test, Likelihood-Ratio (LR) test, the results show that FEM is preferable than POLS because the probability (0.0000) is less than all significance levels (1%, 5% and 10%). Therefore, this leads to the rejection of null hypothesis which claims that POLS is preferable. Next, Lagrange Multiplier (LM) test was used to test either POLS or REM is more suitable. The p-value shows that its probability is less than the significant level of (0.000 < 1%, 5% and 10%). Therefore, REM is more suitable compared with POLS. Moreover, Hausman test was used to compare between FEM and REM indicates that FEM is preferable than REM. The probability of Hausman test which is 0.0000 is lower than all significance level leads to the conclusion where FEM is preferable than REM. Hence, among the three models, FEM is the most appropriate model. It indicates that each country has its own characteristics and it will be taken into account in this analysis. Also, these characteristics do not vary in its effects as time passes.

Since FEM is the most appropriate model, the actual sign from FEM results was used to make comparison with expected sign. The expected relationship between FDI and CO_2 in this study is positive relationship. However, from the results of FEM, FDI has a negative and insignificant relationship with CO_2. The result for FDI in Model 1 is consistent with the result in the study of Phuong and Tuyen (2018) According to Phuong and Tuyen (2018), FDI is found to be insignificant negative and hence, no evidence to conclude that FDI causes the environmental pollution in Vietnam. Moreover, this result is also aligned with the results of Atici (2012). From the results of Atici's study which included ASEAN countries such as Indonesia, Malaysia, Thailand and Philippines, FDI does not have a significant relationship with CO_2 emission. This is because FDI influence is different for all countries most FDI likely invests in non-polluting sectors in low-emissions countries which is not suitable in the ASEAN countries' contexts. Therefore, FDI is found to be insignificant. Also, it is suspected that FDI has indirect relationship with CO_2 emission in ASEAN countries and further analysis will be conducted.

Besides that, the results show that population has a positive relationship with carbon dioxide emission. This indicates that when population increases, carbon dioxide emission also increases. This result for Model 1 is consistent with the expectation stated in the literature review of this study. Rapid growth in population will reduce and deplete the resources such as water, soil fertility and fossil fuel on Earth. In other words, population growth increase consumption of natural resources which cause mismanagement of natural resources (Stephenson, Neyman and Mayhew, 2010). The consequences of mismanagement of natural resources will cause climate change. The study of Vo, Vo and Quan-Thai (2019) also shows that population growth will lead to higher carbon dioxide emission. This is supported by York et. Al. (2003) in which their research shows that a 1% increase in population will lead to a 0.98% increase in ecological footprint.

The third variable, economic growth which is represented by GDP is found to be positively related to CO_2. The expected relationship between GDP and CO_2 emission is positive relationship. This result from Model 1 is consistent with the expected sign in this study. Many past researchers found out that GDP is positively related to climate change. According to Aye and Edoja (2017), the increment of GDP will lead to more carbon dioxide emission due to the expansion of manufacturing sector in the country. Higher economic growth is closely related to more economic developmental activities. Hence, carbon dioxide emission will increase due to the increase in the use of energy.

Next, the fourth explanatory variable, renewable energy is expected to be negatively related to carbon dioxide emission. However, the result from FEM shows that renewable energy consumption in Model 1 is positively related to carbon dioxide emission and it is an insignificant variable. Yaw (2017) found out that regions with high usage of renewable energy consumption such as Washington, Oregon and Idaho have high level of carbon dioxide emission. This indicates that high usage of renewable energy does not necessarily be able to reduce the impact of CO_2 emission. Thus, the results from Yaw's study shows that renewable energy consumption has no relationship with CO_2 emission. Menyah & Wolde-Rufael (2010) also mentioned that renewable energy consumption does not have any significant impact in mitigating the effect of carbon dioxide emission. This is because the renewable energy only consumes a small portion of total energy used. This might also be due to less funding from government for renewable energy's research and development (R&D). In addition, the fall in the prices of natural gas also causes renewable energy to be less attractive when compared to natural gas.

Table 4.3.2:

Model Comparison for Model 2

	Likelihood-Ratio (LR) test	Lagrange Multiplier (LM) test	Hausman test
Test Statistic	73.7720***	35.7151***	99.2958***
Decision Making	Null hypothesis is rejected	Null hypothesis is rejected	Null hypothesis is rejected
Conclusion	FEM is better than POLS	REM is better than POLS	FEM is better than REM

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively.*

Table 4.3.2 depicts the results of Likelihood ratio Test, Lagrange Multiplier (LM) Test and Hausman Test. By referring to the likelihood ratio test results for Model 2, the decision is to reject the null hypothesis at all three level of significance because it has the probability of 0.0000 which is less than 0.01, 0.05, and 0.1. Hence, FEM is more preferable compared to POLS. Besides, the outcomes of LM Test shows that it has a probability of 0.0000 which is lower than significance level and null hypothesis is rejected. Hence, REM is more suitable compared to POLS. Moreover, after conducting the Hausman Test, the result shows that it has the probability of 0.0000 in which leads to the rejection of null hypothesis. Thus, FEM is also preferable compared to REM.

After that, a comparison between the expected sign of each independent variable of this study and the actual sign from the FEM result in Model 2 is conducted. Firstly, the actual sign from the result indicates there is a positive but insignificant relationship between financial development and carbon dioxide emission which is opposite with the expected sign mentioned in earlier chapter of this research. It means that financial development has a positive but insignificant impact on carbon dioxide emissions in the ASEAN countries. The relationship is supported by previous studies (Ozturk and Acaravci, 2013) which concluded that financial development has no significant impact on the CO_2 emissions in Turkey. This finding is similar with Aye and Edoja's (2017) studies, in which financial development rises the amount and scale of manufacturing activities through various financial resources, but this situation does not contribute to pollution and carbon dioxide emissions.

Besides, the relationship between population and carbon dioxide emissions is positive and significant by referring to the results of FEM. It follows the expectation of made in this study in which population has a positive impact towards CO_2 emission. This relationship is supported by majority of the previous studies in which they concluded that size of population will lead to an increase in the level of CO_2 emissions. According to Stephenson, Neyman and Mayhew (2010), they stated that rapid growth in population will deplete more key resources like water, fossil fuel and others on Earth. It means that there will be more consumptions and demands of natural resources and caused mismanagement of resources on energy used. Demographic changes such as size of population and urbanization have positive impacts on CO_2 emission as the emission reacts proportionately to the changes of population size (O'neill et al, 2012).

Not only that, GDP was found to have a significant and positive relationship with CO_2 emissions in our study. This finding is aligned with the expected sign made in this study in which there is a positive relationship between CO_2 emission and GDP. Based on Cederborg and Snöbohm (2016), they concluded that GDP has a positive impact towards carbon dioxide emissions. This is due to the reason of a highly productive country often has greater economic growth activities which becomes one of the factors of rapid industrialisation of the country. In particular, as a country has greater economic development, it has greater industrialisation level and thus increase in level of carbon dioxide emissions because of greater use of energy.

Moreover, renewable energy consumption is discovered to have positive but insignificant relationship towards carbon dioxide emissions. This finding contradicts with the expected sign in this study in which renewable energy consumption should have a significant and negative impact towards carbon dioxide emissions. It means that the consumption of renewable energy does not lead to reductions in CO_2 emissions. According to Menyah & Wolde-Rufael (2010), their study shows that there is no relationship between renewable energy consumption and CO_2 emissions. Perhaps this is because the technology in the renewable energy industry is not fully developed yet and it is still in beginning stage (Lewis and Wiser, 2007). So, the consumption of renewable energy does not reduce the carbon dioxide emission in ASEAN region. Studies from Yaw (2017) also indicates that higher production of renewable energy does not necessarily able to reduce the carbon dioxide emissions.

Table 4.3.3:

Model Comparison for Model 3

	Likelihood-Ratio (LR) test	Lagrange Multiplier (LM) test	Hausman test
Test Statistic	88.0872***	33.7016***	128.5834***
Decision Making	Null hypothesis is rejected	Null hypothesis is rejected	Null hypothesis is rejected
Conclusion	FEM is better than POLS	REM is better than POLS	FEM is better than REM

*Note: The asterisks, *, ** and *** indicate rejection of null hypothesis at 10%, 5% and 1% level of significance respectively*.

Table 4.3.3 depicts the outcomes of model comparison for Model 3. Based on the first test, Likelihood-Ratio (LR) test, the results show that FEM is preferable than POLS because the probability (0.0000) is less than all significance levels (1%, 5% and 10%). Secondly, Lagrange Multiplier (LM) test shows that REM is more preferable than POLS with 0.0000 probability which is lower than all significance level. Next, Hausman test was used to compare between FEM and REM indicates that FEM is preferable than REM. The probability of Hausman test which is 0.0000 is lower than all significance level leads to conclusion where FEM is preferable than REM. Hence, among the three models, FEM is the most appropriate model.

The expected sign of the independent variables is compared with the results obtained. Since FEM is the most appropriate model, the actual sign from FEM results was be used to make comparison with expected sign. First and foremost, while FDI interact with FD, it has a negative relationship with CO_2. The connection between FDI and FD is that when a country is well developed, financial activities like foreign direct investment will increase (Sadorsky, 2010). This is because foreign investors are attracted to the investment opportunities available in the host countries. The negative relationship might be due to foreign investors who invest in clean and green technology wish to reduce carbon dioxide emission in the host countries. These foreign investors have great environmental awareness and wish to employ environmental-friendly technologies to be used in research and development projects. Moreover, this is also supported by pollution halo hypothesis. According to pollution halo hypothesis, multinational companies transfer environmentally friendly technologies to host countries. These environmentally friendly technologies such as pollution abatement technologies help to lessen the impact of CO_2 emission in host countries. The results of this study are also similar with the study of Zhu, Duan, Guo and Yu (2016) regarding the CO_2 emission in ASEAN-5. FDI has a negative influence towards carbon dioxide emission because FDI inflow helps to develop specialized technological skills in production process. Furthermore, multinational companies tend to disseminate cleaner technologies that is less jeopardous to the environment. So, when FDI increases, the environmental quality would improve in the host countries.

However, the interaction between economic growth and financial development shows a positive relationship with CO_2 emission. Choe and Moosa (1999) found out that continuous development in financial sector will cause economic growth.

The results of Chloe and Moosa's research are supported by Eita (2007) and Ngongang (2015). Economic growth can be stimulated in a developed financial system by increasing the efficiency of investment and improve capital accumulation. Atemnkeng et al. (2011) also found out that financial development has a positive effect on economic growth in the long run in Cameroon. The results from FEM model is similar with the study of Cederborg and Snobohm (2016), where correlation that exists between GDP and CO_2 emission is positive. EKC theory also suggests that the country prioritize more on the economy compared to the environment quality when economic development is at its early stage.

Apart from that, when population interacts with financial development, positive relationship was expected to be seen. However, the results from FEM model shows that when population interact with financial development, it is negatively correlated with carbon dioxide emission. However, it was also proven to be insignificant. This might be due to population already has direct relationship with carbon dioxide emission. For the negative relationship, it is possible to be explained that when there is higher financial development in the country, the society will be more developed, and the population will be more concerns on the issue of the climate change. However, there are studies showing that this does not contribute to climate change. According to Knapp and Mookerjee (1996), the interaction between population growth and financial development does not have a long-term relationship with carbon dioxide emission. The results of this study are also supported by Sulaiman & Abdul-Rahim (2018). This means that financial development will not cause population to contribute to climate change issue.

Besides that, the results above show that when renewable energy consumption interacts with financial development, it has negative relationship with carbon dioxide emission. Based on the research of Coban & Topcu (2013), Xu (2012) and Shahbaz, Hye, Tiwari & Leitão (2013), a greater development in financial sector will facilitate the common usage of renewable energy. This is because the rapid growth of industry will generate more demand on renewable energy as the resources on earth will be depleted. To be more specific, financial development leads to growth of industry, generate demand for new infrastructure and thus lead to the demand of renewable energy. The increasing use of renewable energy will eventually help to reduce the carbon dioxide emission and save the environment. For instance, solar energy, wind energy, hydroelectric and biomass are the most common use renewable energy as it will not emit CO_2 and GHG that will accelerate global warming unlike fossil fuels.

4.4 Diagnostic Checking

4.4.1 Detection of Multicollinearity

Multicollinearity problem happens when there is more than one explanatory variable is found to have high correlation with each other among the regression model. The symptoms of multicollinearity are high standard errors, low significance level and extremely high value of R^2. Pair-wise correlation coefficient (covariance matrix) and VIF will be adopted to discover the multicollinearity issue in this study. Table 4.4.1.1, Table 4.4.1.2 and Table 4.4.1.3 show the Covariance Matrix and VIF for Model 1, Model 2 and Model 3 respectively.

Table 4.4.1.1:

Covariance Matrix and VIF for Model 1

Variables	**LNFDI**	**LNPOP**	**LNGDP**	**LNRE**	**VIF**
LNFDI	0.0001	5.5526	-0.0002	1.3571	1.5928
LNPOP	5.5526	0.0012	0.0003	-2.0959	1.1168
LNGDP	-0.0002	0.0003	0.0009	-7.8615	2.0259
LNRE	1.3571	-2.0959	-7.8615	3.3279	1.2800

Table 4.4.1.2:

Covariance Matrix and VIF for Model 2

Variables	LNFD	LNPOP	LNGDP	LNRE	VIF
LNFD	0.0029	0.0014	-0.0005	0.0003	3.0021
LNPOP	0.0014	0.0019	4.1437	0.0001	1.7385
LNGDP	-0.0005	4.1437	0.0006	-0.0001	1.5105
LNRE	0.0003	0.0001	-0.0001	6.8595	2.6753

Table 4.4.1.3:

Covariance Matrix and VIF for Model 3

Variables	LNFDI	LNPOP	LNGDP	LNRE	VIF
LNFDI	0.0002	-1.3788	-0.0002	1.0044	1.8883
LNPOP	-1.3788	0.0027	-0.0003	0.0003	1.6747
LNGDP	-0.0002	-0.0003	0.0008	-6.2529	1.9752
LNRE	1.0044	0.0003	-6.2529	7.9127	1.6876

Based on Table 4.4.1.1, Table 4.4.1.2 and Table 4.4.1.3, the covariance matrix results show that there is no strong correlation between the independent variables in Model 1, Model 2 and Model 3 respectively. Apart from that, Variance Inflation Factor (VIF) also shows that there is no serious multicollinearity problem because the VIF values for all of the variables are less than 10 for all the three models. Hence, there is no serious multicollinearity problem and the variables are verified and can be used to conduct the regression analysis.

4.4.2 Detection of Normality, Heteroscedasticity and Autocorrelation

Table 4.4.2.1:

Diagnostic Checking Results

Model	**(1)**	**(2)**	**(3)**
Diagnostic Checking:			
LM Test	1.9262**	1.9280***	1.8994**
	(0.0000)	(0.0000)	(0.0000)
BP-Godfrey test	6.9554	9.6799**	6.1966
	(0.1383)	(0.0462)	(0.1849)
Normality test	2.6681	3.4167	1.3872
	(0.2634)	(0.1812)	(0.4998)

*Notes: P-value is written in parentheses. *, ** and *** denote rejection at the 10%, 5%, and 1% significance levels respectively.*

Table 4.4.2.1 displays the outcomes of serial correlation, heteroscedasticity and normality distribution test. Firstly, the Breusch-Godfrey Serial Correlation LM test is used to test whether a model is serial correlated by determining its Durbin-Watson statistics. The result shows that all of the three models do not have autocorrelation problem because the Durbin-Watson statistics for these three models are approximately to 2. Hence, there is no autocorrelation in all models in this study. This proved that they are consistent and unbiased.

For the outcome of Breusch-Pagan-Godfrey Test, for Model 1 and Model 3, the probability of 0.1383 and 0.1849 are greater than 1%, 5%, and 10% level of significance. Thus, the null hypothesis will not be rejected, and this indicates that Model 1 and 2 are free from heteroscedasticity problem

(Homoscedasticity). In Model 3, the results of BP test show the probability of 0.0462 which is higher than 0.01 (1%) significance level. Therefore, no rejection of the null hypothesis of hypothesis testing at 1% significance level. In short, there is enough evidence to prove that there is no heteroscedasticity issue for the three models.

Moreover, Table 4.4.2.1 also shows the results of Jarque-Bera test which is the normality test for the three models. The normality test probability for model 1 (0.2634), model 2 (0.1812) and model 3 (0.4998) are higher than all three significances level. Hence, this proves that the error term for all models is normally distributed. In short, all of the three models are exempted from the econometric problems like autocorrelation, heteroscedasticity and non-normality of model.

CHAPTER 5: CONCLUSION

5.0 Introduction

In the following chapter, a detailed discussion will be revealed based on the overall results and findings in previous chapters. Section 5.1 discusses the major findings of this study, followed by the implications of study in 5.2 to provide some insights for various related parties in addressing respective issues. Lastly, recommendations for future researches will be presented in section 5.4 with respect to the limitations exhibited in section 5.3.

5.1 Discussion of Major Findings

To sum up this study, the main objective is to examine the significant factors that contribute to climate change and how financial development acts as an interaction term in overall affecting the climate change in the selected ASEAN countries from 2006 to 2015. As such, Pooled Ordinary Least Squares (POLS) is being applied, along with unit root test, Hausman Test, Likelihood Ratio Test and few diagnostic checking tests. There are three models being tested in this study excluding the base model. The first model includes the basic variables such as population, economic growth and renewable energy consumption in the addition of foreign direct investment as independent variable. The second model includes the basic variables and financial development as independent variable while in the fourth model, financial development will be used as an interaction term in order to examine its overall effect on climate change.

By employing Hausman Test and Likelihood Test, Fixed Effect Model (FEM) is found to be the most appropriate model, hence it will be used to interpret all four models in this research. In model one, the outcomes show that population, economic growth and renewable energy consumption are positively significant in explaining the climate change in selected ASEAN countries while foreign direct investment is not significant in this case. The coefficients of all variables except foreign direct investment exhibit positive signs, implying that an increase in the independent variables can lead to more emission of carbon dioxides. The insignificancy of FDI is aligned with the result of few researches. For instance, from the results of Atici's study which included ASEAN countries such as Indonesia, Malaysia, Thailand and Philippines, FDI does not have a significant relationship with CO_2 emission. This is because FDI influence is different for all countries. Therefore, FDI is found to be insignificant.

In the case of model two, only population and economic growth are found to impose a significant and positive effect on climate change. Financial development and renewable energy consumption are found to be insignificant positively affecting climate change. The actual sign from the result shows that there is a positive but insignificant relationship between financial development and carbon dioxide emission. It shows the same results in the study of Aye and Edoja's (2017), in which financial development rises the amount and scale of manufacturing activities through various financial resources, but this situation does not contribute to pollution and carbon dioxide emissions.

In model 3, foreign direct investment, gross domestic product and renewable energy consumption are found to be significantly affecting emission of carbon dioxide when interacting with financial development. The actual sign from the result is consistent with our expectation in which FDI should have negative relationship, GDP should have positive relationship and renewable energy consumption should have negative relationship on carbon dioxide emission when interacting with FD. In the case, only population is inconsistent with the expectation made in this study because it exhibits an insignificant relationship according to the empirical results.

This might be due it already has direct relationship with carbon dioxide emission and for the negative relationship it can be explained in the way that when there is higher financial development in the country, the society will be more developed and the population will be more aware of the issue of the climate change and thus tend to improve the economic condition back.

In short, the objectives in this study which are to investigate the significant factors that contribute to climate change and how financial development acts as an interaction term in overall affecting the climate change in the selected ASEAN countries from 2006 to 2015 have been achieved through the panel data analysis

5.2 Implication of Study

Climate change issues has become one of the concerns that must be discussed. The issue has raised the awareness globally and many countries have initiated to take actions in attempting to reduce the carbon dioxide emissions in each of the countries themselves. Based on the results of the study, there are several policies suggested to solve the problems between financial development and the carbon dioxide emission levels and these policy implications should be considered and carried out by government and policy makers in order to improve the environmental quality in ASEAN countries.

Firstly, to prevent the damaging effect of financial development on environment, governments in ASEAN region should develop financial markets by allocating and using the funds in projects that introduce low-carbon and renewable energy technologies. This is to increase the motivation of firms to lower down the carbon dioxide emissions. For instance, the local government should direct their central bank to monitor the allocation method of financial resources of each bank. Then, the banks should monitor the enterprises after financial resources are allocated to ensure that credit is not being used at the cost of environmental quality. If any enterprise is involved in any activity that brings into environmental degradation, authority should penalise those who default by placing slightly higher interest rate on loans and paying for fines as punishments. Besides, the government should also motivate the banking sector to invest in the business that utilise renewable energy with the purpose to achieve sustainable environment. In particular, the banking industry should place financial resources for R&D in inventing energy-efficient technologies. Banking sector could also use part of the financial resources to buy patents for these technologies in order to earn some profits as part of their incomes and thus reducing environmental degradation.

Based on our studies, since FDI is one of the factors that causes in the emissions of carbon dsioxide, governments in ASEAN countries should consider the implementation of policies as to attract foreign investment from advanced and developed countries like China and United States. In order to reduce environmental damage, foreign countries are advisable to transfer technology in environment-friendly projects to the host countries. Governments also should strengthen the environmental standards and improve environmental supervision of foreign companies. For example, government could collect an energy tax on FDI-invested companies that consume high level of energy and release high level of pollutant and carbon dioxide emission. Relevant laws and regulations should be strictly imposed by government to penalise those companies which violate the rules in order to improve the environmental quality.

It is essential to increase the environmental awareness among the citizens in every country, because it is quite hard to control the usage for energy as the population grows. By increasing awareness of citizens, government can easily impose regulations to counter environmental degradation problem. They are encouraged to use gadgets and facilities that can save energy such as solar panels, solar powered household items and energy conserving electric bulbs. The government can offer them at subsidised rates since some of the gadgets are costly to be purchased.

Increase in population will lead to more deforestation by the citizens, it is because humans need place to live and build their residence. Hence, government should strictly monitor the rate of deforestation since it will release more carbon dioxide into the atmosphere. Governments also advised to set emission standards for industries and use emission monitoring strategies to reduce environmental degradation level.

The adoption of renewable energy solutions that work with energy efficiency strategies will help to achieve over 90% of carbon dioxide emission reductions (Irena, 2019). According to Irena (2019), the power systems generated by renewable energy can function more efficient while supporting sustained economic growth. As solutions, electricity sector needs to be totally decarbonised for the energy transition which can be achieved by making good use of renewable energy, increasing energy efficiency and adjusting power systems more flexible. Besides, industrial sector is one of the largest emitters, but the attentions given to the policies is not enough. The government should take some policy interventions such as provide financial incentives like grants and tax credits, set renewable portfolio standards by setting a quota for renewable heat. Indeed, the industrial sector plays a vital role in decarbonization by increasing self-production and consumption from renewable energy. Wind and solar technologies in combination with energy efficiency should be applied and constitute a distributed energy resource application together.

5.3 Limitations of Study

After conducting this research, several limitations faced which may affect the accuracy of results would like to be addressed. Future researchers that are interested in the issue of climate change can refer to the limitations of this research and overcome the limitations accordingly. Below are the limitations of this study.

Limitation of data is the first limitation in this study. Due to limited data, the scope of analysis has to be reduced. This became an obstacle to study the climate change in all of the ASEAN countries. This research consists of the data of 5 selected ASEAN countries namely Malaysia, Philippines, Thailand, Indonesia and Vietnam. A total of 100 observations has been used the yearly data of 5 ASEAN countries from 1996 to 2015. More data is expected to be collected initially because more data will increase the accuracy of results. This would help to get a more precise estimation for the relationship between dependent variable and independent variables. However, throughout the process of collecting data, there are missing data for year 2016 and onwards. So, the data collected might not reflect the current situation of the 5 countries and the results obtained might be less accurate.

Another limitation of this study is the omission of relevant variables. The model of this research consists of 5 independent variables, Renewable Energy, Population, Economic Growth, FDI and Financial Development. However, the models used in this research are believed to not have included some of the relevant determinants of climate change like Trade Openness, Energy Consumption and more. The reason why other determinants were not included in the model is because of limitation of data and the restriction of the topic. As this research emphasizes more on the contribution of Financial Development on Climate Change, it is advisable to only add in variables that are related to Financial Development into the model. So, Foreign Direct Investment was added into the model instead of Trade Openness and Energy Consumption as FDI is more relevant to Financial Development. Limitation of data was also one of the reasons why some variables were omitted. As most of the countries in ASEAN region are still developing, only limited data on those countries could be obtained. So, some of the variables had to be omitted from the study.

In a nutshell, future researchers shall be aware of these limitations when conducting their research. These limitations will help to improve the accuracy of their results.

5.4 Recommendations of Study

To overcome the limitations found in this study, few recommendations are suggested for future researchers.

First and foremost, one of the recommendations for future researchers to overcome limitation of data is to extend the research which include other countries besides ASEAN countries. Future researchers should not be restricted to only ASEAN countries since there is data limitation problem. The impact of climate change does not only affect ASEAN countries but also other countries such as Australia and New Zealand. It would be better if future researchers can add on countries that has the similar demography or economy condition as the other ASEAN countries into the research. Besides that, future researchers can also include developed countries rather than just developing countries. With that, the results will be able to capture the actual effect of the variables towards climate change. For instance, the study by Pao and Tsai (2001) about the association between CO_2 emission and FDI on the BRIC countries shows that the researchers chose countries with similar economy condition. The BRIC countries include Brazil, Russia, India and China. These 4 nations are known to represent the world's economy. Hence, future researchers can consider including countries other than the 5 ASEAN countries. Furthermore, by doing so, the sample size of the study will increase. Larger sample size provides more accurate results and the results will be more convincing.

Apart from that, as mentioned above, one of the limitations in the research is the omission of variables. There are two problems that cause this limitation which are the restriction of topic and the limitation of data. Future researchers on the issue of climate change are advisable to extend the model with more relevant variables so that more determinants of climate change could be identified. As there are still many determinants of climate change that have not been identified, future researchers can include more variables in their model so that actions can be taken against the significant determinants. Future researchers are also advised to further their study to other regions with developed countries as the information on developed countries could be obtained more easily. Usually, developed countries have complete information and data and there are more researches done on developed countries. So, future researchers could have more reference when they do their research.

All in all, future researchers can take the recommendations of this study as a guidance for the use of their future study. These recommendations are hoped to be able to help future researchers in producing a quality study.

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APPENDICES

Appendix 4.1 Panel Unit Root Test for CO_2 (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_CO2
Date: 02/25/20 Time: 00:24
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 90
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-2.64564	0.0041

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_CO2

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	0.00442	5.E-07	2.E-05	1	1	3.0	18
Malaysia	-0.01724	2.E-06	3.E-05	1	1	2.0	18
Thailand	-0.02520	8.E-07	8.E-05	1	1	3.0	18
Vietnam	0.00046	2.E-06	3.E-05	1	1	3.0	18
Indonesia	-0.00080	6.E-06	1.E-05	1	1	1.0	18
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.00578	-2.792	1.204	-0.554	0.919		90

Appendix 4.2 Panel Unit Root Test for CO_2 (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_CO2
Date: 02/25/20 Time: 00:25
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 87
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.66431	0.0480

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_CO2

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.14188	3.E-07	6.E-06	3	3	2.0	16
Malaysia	-0.06422	3.E-06	1.E-06	0	3	8.0	19
Thailand	-0.03060	3.E-07	3.E-06	3	3	0.0	16
Vietnam	-0.17201	9.E-07	1.E-05	1	3	2.0	18
Indonesia	-0.74745	3.E-06	1.E-05	1	3	1.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.06291	-3.764	1.145	-0.703	1.003		87

Appendix 4.3 Panel Unit Root Test for FDI (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_FDI2
Date: 02/25/20 Time: 00:28
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.48531	0.0687

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_FDI2

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.39880	0.2317	0.1695	0	0	1.0	19
Malaysia	-0.96935	0.9784	0.1434	0	0	14.0	19
Thailand	-0.99150	0.1840	0.0406	0	0	12.0	19
Vietnam	-0.00027	0.0560	0.0763	0	0	1.0	19
Indonesia	-0.36877	1.0194	0.1872	0	0	18.0	19

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.23439	-3.234	1.161	-0.554	0.919		95

Appendix 4.4 Panel Unit Root Test for FDI (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_FDI2
Date: 02/25/20 Time: 00:29
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 93
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-4.89415	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_FDI2

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.65966	0.1808	0.1396	0	3	2.0	19
Malaysia	-1.09220	0.8337	0.1201	0	3	13.0	19
Thailand	-1.28031	0.1349	0.0291	0	3	11.0	19
Vietnam	-0.39048	0.0305	0.0677	1	3	1.0	18
Indonesia	-1.17909	0.5014	0.1141	1	3	18.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.75106	-8.335	1.108	-0.703	1.003		93

Appendix 4.5 Panel Unit Root Test for FD (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG FD
Date: 02/25/20 Time: 00:32
Sample: 1996 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 93
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-3.30312	0.0005

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.23350	0.0009	0.0008	0	4	2.0	19
Malaysia	-0.18710	0.0008	0.0010	0	4	1.0	19
Thailand	-0.24257	0.0003	0.0015	1	4	1.0	18
Vietnam	-0.06395	0.0017	0.0020	0	4	0.0	19
Indonesia	-0.11191	0.0004	0.0013	1	4	2.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.12622	-4.782	1.048	-0.554	0.919		93

Appendix 4.6 Panel Unit Root Test for FD (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG FD
Date: 02/25/20 Time: 00:33
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 90
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	0.35399	0.6383

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.16929	0.0003	7.E-05	1	1	18.0	18
Malaysia	-0.20272	0.0006	0.0007	1	1	3.0	18
Thailand	-0.16169	0.0002	0.0013	1	1	1.0	18
Vietnam	-0.18678	0.0016	0.0007	1	1	5.0	18
Indonesia	-0.17636	0.0004	0.0012	1	1	2.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.17188	-3.547	1.000	-0.703	1.003		90

Appendix 4.7 Panel Unit Root Test for Population (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_POP
Date: 02/25/20 Time: 00:25
Sample: 1996 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 2 to 4
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 79
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-3.54863	0.0002

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_POP

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.00692	6.E-10	3.E-06	2	4	3.0	17
Malaysia	-0.00449	7.E-11	8.E-06	4	4	3.0	15
Thailand	-0.00725	3.E-10	4.E-06	4	4	3.0	15
Vietnam	-0.18132	1.E-05	2.E-05	3	4	0.0	16
Indonesia	-0.00029	5.E-11	6.E-08	3	4	2.0	16

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.00110	-3.692	1.824	-0.554	0.919		79

Appendix 4.8 Panel Unit Root Test for Population (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_POP
Date: 02/25/20 Time: 00:26
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-6.78341	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_POP

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.06590	6.E-08	3.E-07	0	0	3.0	19
Malaysia	-0.00344	1.E-07	2.E-07	0	0	2.0	19
Thailand	-0.11405	2.E-08	4.E-07	0	0	3.0	19
Vietnam	-0.27018	1.E-05	1.E-05	0	0	3.0	19
Indonesia	-0.23859	4.E-09	2.E-08	0	0	2.0	19
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.08517	-7.911	1.173	-0.703	1.003		95

Appendix 4.9 Panel Unit Root Test for GDP (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_GDP
Date: 02/26/20 Time: 23:21
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 3
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 80
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-3.20681	0.0007

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_GDP

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.04808	0.0008	0.0019	3	3	2.0	16
Malaysia	-0.09867	0.0014	0.0033	3	3	1.0	16
Thailand	-0.10137	0.0006	0.0036	3	3	1.0	16
Vietnam	-0.04569	0.0004	0.0011	3	3	2.0	16
Indonesia	-0.08037	0.0012	0.0093	3	3	2.0	16

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.06782	-4.300	1.014	-0.554	0.919		80

Appendix 4.10 Panel Unit Root Test for GDP (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_GDP
Date: 02/26/20 Time: 23:22
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-2.51322	0.0060

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_GDP

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.28047	0.0009	0.0012	0	0	0.0	19
Malaysia	-0.52670	0.0021	0.0029	0	0	2.0	19
Thailand	-0.44638	0.0011	0.0030	0	0	1.0	19
Vietnam	-0.25093	0.0005	0.0010	0	0	2.0	19
Indonesia	-0.60127	0.0061	0.0086	0	0	2.0	19

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.38217	-7.033	1.028	-0.703	1.003		95

Appendix 4.11 Panel Unit Root Test for Renewable Energy (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_RE
Date: 02/25/20 Time: 00:27
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.37746	0.0842

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_RE

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.14950	0.0002	2.E-05	0	0	18.0	19
Malaysia	-0.13392	0.0008	0.0011	0	0	1.0	19
Thailand	-0.15611	0.0002	0.0002	0	0	1.0	19
Vietnam	-0.03861	0.0002	0.0003	0	0	0.0	19
Indonesia	-0.04818	8.E-05	6.E-05	0	0	3.0	19

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.06570	-2.451	1.013	-0.554	0.919		95

Appendix 4.12 Panel Unit Root Test for Renewable Energy (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG_RE
Date: 02/25/20 Time: 00:28
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 90
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	0.48804	0.6872

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG_RE

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-1.24075	8.E-05	2.E-05	1	1	18.0	18
Malaysia	0.00282	0.0008	0.0008	1	1	1.0	18
Thailand	-0.32155	0.0002	0.0002	1	1	0.0	18
Vietnam	-0.37373	0.0002	0.0003	1	1	0.0	18
Indonesia	-0.62964	6.E-05	5.E-05	1	1	4.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.44099	-4.517	1.075	-0.703	1.003		90

Appendix 4.13 Panel Unit Root Test for FDI interact with FD (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG FDI FD
Date: 02/25/20 Time: 00:39
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.14301	0.1265

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG FDI FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.39293	0.2297	0.2713	0	0	0.0	19
Malaysia	-0.96926	0.9549	0.1444	0	0	14.0	19
Thailand	-1.08515	0.1682	0.0303	0	0	13.0	19
Vietnam	0.00546	0.0599	0.0786	0	0	1.0	19
Indonesia	-0.40254	0.9988	0.1848	0	0	18.0	19
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.16875	-2.665	1.198	-0.554	0.919		95

Appendix 4.14 Panel Unit Root Test for FDI interact with FD (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG FDI FD
Date: 02/25/20 Time: 00:39
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 93
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-4.86592	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG FDI FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.59666	0.1856	0.1356	0	3	2.0	19
Malaysia	-1.07537	0.8287	0.1150	0	3	13.0	19
Thailand	-1.28848	0.1337	0.0259	0	3	13.0	19
Vietnam	-0.40003	0.0362	0.0737	1	3	1.0	18
Indonesia	-1.18118	0.5001	0.1070	1	3	18.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.77536	-8.338	1.100	-0.703	1.003		93

Appendix 4.15 Panel Unit Root Test for Population interact with FD (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG POP FD
Date: 02/25/20 Time: 00:35
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 2
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 85
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-2.54169	0.0055

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG POP FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	0.12690	0.0004	0.0008	2	2	2.0	17
Malaysia	-0.05926	0.0007	0.0009	2	2	2.0	17
Thailand	-0.23674	0.0003	0.0015	2	2	1.0	17
Vietnam	-0.13765	0.0012	0.0021	2	2	0.0	17
Indonesia	-0.22257	0.0004	0.0013	2	2	2.0	17
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.14887	-4.620	1.026	-0.554	0.919		85

Appendix 4.16 Panel Unit Root Test for Population interact with FD (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG POP FD
Date: 02/25/20 Time: 00:36
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 90
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	0.41402	0.6606

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG POP FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.17987	0.0003	7.E-05	1	1	18.0	18
Malaysia	-0.23647	0.0006	0.0007	1	1	3.0	18
Thailand	-0.16611	0.0002	0.0013	1	1	1.0	18
Vietnam	-0.18789	0.0016	0.0006	1	1	6.0	18
Indonesia	-0.17836	0.0004	0.0013	1	1	2.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.17977	-3.596	1.001	-0.703	1.003		90

Appendix 4.17 Panel Unit Root Test for GDP interact with FD (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG GDP FD
Date: 02/25/20 Time: 00:37
Sample: 1996 2015
Exogenous variables: Individual effects
User-specified lags: 5
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 70
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.79465	0.0364

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG GDP FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.13296	0.0005	0.0034	5	5	2.0	14
Malaysia	-0.22994	0.0005	0.0024	5	5	0.0	14
Thailand	-0.08190	0.0004	0.0046	5	5	2.0	14
Vietnam	-0.06131	0.0010	0.0027	5	5	2.0	14
Indonesia	0.01912	0.0009	0.0058	5	5	7.0	14

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.08013	-3.612	1.041	-0.554	0.919		70

Appendix 4.18 Panel Unit Root Test for GDP interact with FD (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG GDP FD
Date: 02/25/20 Time: 00:38
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 95
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-1.73080	0.0417

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG GDP FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.19780	0.0019	0.0012	0	0	4.0	19
Malaysia	-0.34317	0.0017	0.0021	0	0	1.0	19
Thailand	-0.22948	0.0013	0.0022	0	0	1.0	19
Vietnam	-0.08012	0.0017	0.0022	0	0	1.0	19
Indonesia	-0.66539	0.0055	0.0023	0	0	13.0	19

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.25954	-4.967	1.043	-0.703	1.003		95

Appendix 4.19 Panel Unit Root Test for Renewable Energy interact with FD (Individual Effects, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG RE FD
Date: 02/25/20 Time: 00:34
Sample: 1996 2015
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 89
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-4.34062	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG RE FD

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.19286	0.0007	0.0007	0	4	2.0	19
Malaysia	-0.25602	0.0008	0.0027	3	4	2.0	16
Thailand	-0.25953	0.0006	0.0019	1	4	1.0	18
Vietnam	-0.12787	0.0011	0.0014	1	4	1.0	18
Indonesia	-0.19696	0.0005	0.0014	1	4	2.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.18951	-6.058	1.019	-0.554	0.919		89

Appendix 4.20 Panel Unit Root Test for Renewable Energy interact with FD (Individual Effects, Individual Linear Trends, Level Form)

Null Hypothesis: Unit root (common unit root process)
Series: LOG RE FD
Date: 02/25/20 Time: 00:34
Sample: 1996 2015
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 90
Cross-sections included: 5

Method	Statistic	Prob.**
Levin, Lin & Chu t*	0.35557	0.6389

** Probabilities are computed assuming asympotic normality

Intermediate results on LOG RE FD_

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
Philiphine	-0.22402	0.0003	8.E-05	1	1	9.0	18
Malaysia	0.05435	0.0014	0.0015	1	1	0.0	18
Thailand	-0.18119	0.0005	0.0016	1	1	1.0	18
Vietnam	-0.22728	0.0011	0.0001	1	1	15.0	18
Indonesia	-0.21265	0.0005	0.0014	1	1	2.0	18

	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.16947	-3.127	1.015	-0.703	1.003		90

Appendix 4.21 Pooled OLS for Model 1

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/24/20 Time: 23:56
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FDI2	-0.002437	0.010056	-0.242305	0.8091
LOG_GDP	0.567647	0.029323	19.35850	0.0000
LOG_POP	-0.195300	0.035229	-5.543789	0.0000
LOG_RE	0.063324	0.005769	10.97696	0.0000
C	3.442238	0.296408	11.61319	0.0000

R-squared	0.932688	Mean dependent var	9.453472
Adjusted R-squared	0.929854	S.D. dependent var	0.276428
S.E. of regression	0.073212	Akaike info criterion	-2.342199
Sum squared resid	0.509204	Schwarz criterion	-2.211941
Log likelihood	122.1100	Hannan-Quinn criter.	-2.289481
F-statistic	329.0836	Durbin-Watson stat	0.263569
Prob(F-statistic)	0.000000		

Appendix 4.22 Pooled OLS for Model 2

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:09
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FD	0.063831	0.054154	1.178698	0.2415
LOG_GDP	0.553351	0.025144	22.00710	0.0000
LOG_POP	-0.164393	0.043649	-3.766225	0.0003
LOG_RE	0.070876	0.008282	8.557609	0.0000
C	3.352621	0.303748	11.03749	0.0000

R-squared	0.933617	Mean dependent var	9.453472
Adjusted R-squared	0.930822	S.D. dependent var	0.276428
S.E. of regression	0.072705	Akaike info criterion	-2.356100
Sum squared resid	0.502175	Schwarz criterion	-2.225841
Log likelihood	122.8050	Hannan-Quinn criter.	-2.303382
F-statistic	334.0225	Durbin-Watson stat	0.261474
Prob(F-statistic)	0.000000		

Appendix 4.23 Pooled OLS for Model 3

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:20
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_RE_FD	0.100313	0.008895	11.27709	0.0000
LOG_POP_FD	-0.249512	0.051890	-4.808477	0.0000
LOG_GDP_FD	0.422309	0.028472	14.83231	0.0000
LOG_FDI_FD	0.000138	0.012368	0.011165	0.9911
C	4.552523	0.311831	14.59933	0.0000

R-squared	0.898544	Mean dependent var	9.453472
Adjusted R-squared	0.894272	S.D. dependent var	0.276428
S.E. of regression	0.089883	Akaike info criterion	-1.931914
Sum squared resid	0.767497	Schwarz criterion	-1.801655
Log likelihood	101.5957	Hannan-Quinn criter.	-1.879196
F-statistic	210.3413	Durbin-Watson stat	0.121861
Prob(F-statistic)	0.000000		

Appendix 4.24 FEM for Model 1

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/24/20 Time: 23:57
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FDI2	-0.013863	0.008505	-1.629866	0.1066
LOG_GDP	0.344089	0.048789	7.052643	0.0000
LOG_POP	1.738373	0.301424	5.767192	0.0000
LOG_RE	0.006246	0.095209	0.065602	0.9478
C	2.030411	0.487659	4.163591	0.0001

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.969149	Mean dependent var	9.453472
Adjusted R-squared	0.966437	S.D. dependent var	0.276428
S.E. of regression	0.050642	Akaike info criterion	-3.042372
Sum squared resid	0.233382	Schwarz criterion	-2.807906
Log likelihood	161.1186	Hannan-Quinn criter.	-2.947479
F-statistic	357.3329	Durbin-Watson stat	0.206321
Prob(F-statistic)	0.000000		

Appendix 4.25 FEM for Model 2

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:09
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FD	0.007533	0.052983	0.142175	0.8873
LOG_GDP	0.296729	0.045584	6.509502	0.0000
LOG_POP	1.858837	0.345822	5.375120	0.0000
LOG_RE	0.004346	0.126555	0.034337	0.9727
C	2.020286	0.648141	3.117046	0.0024

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.968255	Mean dependent var	9.453472
Adjusted R-squared	0.965465	S.D. dependent var	0.276428
S.E. of regression	0.051370	Akaike info criterion	-3.013820
Sum squared resid	0.240142	Schwarz criterion	-2.779355
Log likelihood	159.6910	Hannan-Quinn criter.	-2.918928
F-statistic	346.9544	Durbin-Watson stat	0.178728
Prob(F-statistic)	0.000000		

Appendix 4.26 FEM for Model 3

Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:18
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_RE_FD	-0.514994	0.099546	-5.173429	0.0000
LOG_POP_FD	-0.174699	0.115971	-1.506407	0.1354
LOG_GDP_FD	0.560015	0.044114	12.69467	0.0000
LOG_FDI_FD	-0.019874	0.009879	-2.011799	0.0472
C	5.257263	0.351413	14.96035	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.957954	Mean dependent var	9.453472
Adjusted R-squared	0.954258	S.D. dependent var	0.276428
S.E. of regression	0.059121	Akaike info criterion	-2.732786
Sum squared resid	0.318067	Schwarz criterion	-2.498321
Log likelihood	145.6393	Hannan-Quinn criter.	-2.637894
F-statistic	259.1648	Durbin-Watson stat	0.413162
Prob(F-statistic)	0.000000		

Appendix 4.27 REM for Model 1

Dependent Variable: LOG CO2
Method: Panel EGLS (Cross-section random effects)
Date: 02/24/20 Time: 23:58
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG FDI2	-0.002437	0.006956	-0.350295	0.7269
LOG GDP	0.567647	0.020283	27.98613	0.0000
LOG POP	-0.195300	0.024368	-8.014527	0.0000
LOG RE	0.063324	0.003990	15.86914	0.0000
C	3.442238	0.205030	16.78892	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.000000	0.0000
Idiosyncratic random	0.050642	1.0000

Weighted Statistics

R-squared	0.932688	Mean dependent var	9.453472
Adjusted R-squared	0.929854	S.D. dependent var	0.276428
S.E. of regression	0.073212	Sum squared resid	0.509204
F-statistic	329.0836	Durbin-Watson stat	0.263569
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.932688	Mean dependent var	9.453472
Sum squared resid	0.509204	Durbin-Watson stat	0.263569

Appendix 4.28 REM for Model 2

Dependent Variable: LOG CO2
Method: Panel EGLS (Cross-section random effects)
Date: 02/25/20 Time: 00:10
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG FD	0.063831	0.038263	1.668228	0.0986
LOG GDP	0.553351	0.017766	31.14696	0.0000
LOG POP	-0.164393	0.030841	-5.330390	0.0000
LOG RE	0.070876	0.005852	12.11170	0.0000
C	3.352621	0.214616	15.62152	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.000000	0.0000
Idiosyncratic random	0.051370	1.0000

Weighted Statistics

R-squared	0.933617	Mean dependent var	9.453472
Adjusted R-squared	0.930822	S.D. dependent var	0.276428
S.E. of regression	0.072705	Sum squared resid	0.502175
F-statistic	334.0225	Durbin-Watson stat	0.261474
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.933617	Mean dependent var	9.453472
Sum squared resid	0.502175	Durbin-Watson stat	0.261474

Appendix 4.29 REM for Model 3

Dependent Variable: LOG CO2
Method: Panel EGLS (Cross-section random effects)
Date: 02/25/20 Time: 00:18
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG RE FD	0.100313	0.005851	17.14489	0.0000
LOG POP FD	-0.249512	0.034131	-7.310473	0.0000
LOG GDP FD	0.422309	0.018728	22.55001	0.0000
LOG FDI FD	0.000138	0.008135	0.016975	0.9865
C	4.552523	0.205107	22.19580	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	1.28E-07	0.0000
Idiosyncratic random	0.059121	1.0000

Weighted Statistics

R-squared	0.898544	Mean dependent var	9.453472
Adjusted R-squared	0.894272	S.D. dependent var	0.276428
S.E. of regression	0.089883	Sum squared resid	0.767497
F-statistic	210.3413	Durbin-Watson stat	0.121861
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.898544	Mean dependent var	9.453472
Sum squared resid	0.767497	Durbin-Watson stat	0.121861

Appendix 4.30 Likelihood-Ratio (LR) test for Model 1

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	26.887064	(4,91)	0.0000
Cross-section Chi-square	78.017267	4	0.0000

Cross-section fixed effects test equation:
Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:02
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FDI2	-0.002437	0.010056	-0.242305	0.8091
LOG_GDP	0.567647	0.029323	19.35850	0.0000
LOG_POP	-0.195300	0.035229	-5.543789	0.0000
LOG_RE	0.063324	0.005769	10.97696	0.0000
C	3.442238	0.296408	11.61319	0.0000

R-squared	0.932688	Mean dependent var	9.453472
Adjusted R-squared	0.929854	S.D. dependent var	0.276428
S.E. of regression	0.073212	Akaike info criterion	-2.342199
Sum squared resid	0.509204	Schwarz criterion	-2.211941
Log likelihood	122.1100	Hannan-Quinn criter.	-2.289481
F-statistic	329.0836	Durbin-Watson stat	0.263569
Prob(F-statistic)	0.000000		

Appendix 4.31 Likelihood-Ratio (LR) test for Model 2

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	24.823943	(4,91)	0.0000
Cross-section Chi-square	73.772005	4	0.0000

Cross-section fixed effects test equation:
Dependent Variable: LOG CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:12
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG FD	0.063831	0.054154	1.178698	0.2415
LOG GDP	0.553351	0.025144	22.00710	0.0000
LOG POP	-0.164393	0.043649	-3.766225	0.0003
LOG RE	0.070876	0.008282	8.557609	0.0000
C	3.352621	0.303748	11.03749	0.0000

R-squared	0.933617	Mean dependent var	9.453472
Adjusted R-squared	0.930822	S.D. dependent var	0.276428
S.E. of regression	0.072705	Akaike info criterion	-2.356100
Sum squared resid	0.502175	Schwarz criterion	-2.225841
Log likelihood	122.8050	Hannan-Quinn criter.	-2.303382
F-statistic	334.0225	Durbin-Watson stat	0.261474
Prob(F-statistic)	0.000000		

Appendix 4.32 Likelihood-Ratio (LR) test for Model 3

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	32.145839	(4,91)	0.0000
Cross-section Chi-square	88.087241	4	0.0000

Cross-section fixed effects test equation:
Dependent Variable: LOG CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:21
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG RE FD	0.100313	0.008895	11.27709	0.0000
LOG POP FD	-0.249512	0.051890	-4.808477	0.0000
LOG GDP FD	0.422309	0.028472	14.83231	0.0000
LOG FDI FD	0.000138	0.012368	0.011165	0.9911
C	4.552523	0.311831	14.59933	0.0000

R-squared	0.898544	Mean dependent var	9.453472
Adjusted R-squared	0.894272	S.D. dependent var	0.276428
S.E. of regression	0.089883	Akaike info criterion	-1.931914
Sum squared resid	0.767497	Schwarz criterion	-1.801655
Log likelihood	101.5957	Hannan-Quinn criter.	-1.879196
F-statistic	210.3413	Durbin-Watson stat	0.121861
Prob(F-statistic)	0.000000		

Appendix 4.33 Lagrange Multiplier (LM) test for Model 1

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	38.87819	12.80336	51.68155
	(0.0000)	(0.0003)	(0.0000)
Honda	6.235237	3.578179	6.939133
	(0.0000)	(0.0002)	(0.0000)
King-Wu	6.235237	3.578179	7.159369
	(0.0000)	(0.0002)	(0.0000)
Standardized Honda	13.64831	3.808142	5.351162
	(0.0000)	(0.0001)	(0.0000)
Standardized King-Wu	13.64831	3.808142	8.411613
	(0.0000)	(0.0001)	(0.0000)
Gourieroux, et al.*	--	--	51.68155
			(0.0000)

Appendix 4.34 Lagrange Multiplier (LM) test for Model 2

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	22.67422	13.04092	35.71513
	(0.0000)	(0.0003)	(0.0000)
Honda	4.761745	3.611221	5.920581
	(0.0000)	(0.0002)	(0.0000)
King-Wu	4.761745	3.611221	5.833901
	(0.0000)	(0.0002)	(0.0000)
Standardized Honda	10.23463	3.797745	3.927477
	(0.0000)	(0.0001)	(0.0000)
Standardized King-Wu	10.23463	3.797745	6.010549
	(0.0000)	(0.0001)	(0.0000)
Gourieroux, et al.*	--	--	35.71513
			(0.0000)

Appendix 4.35 Lagrange Multiplier (LM) test for Model 3

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	8.354152 (0.0038)	25.34743 (0.0000)	33.70158 (0.0000)
Honda	2.890355 (0.0019)	5.034623 (0.0000)	5.603806 (0.0000)
King-Wu	2.890355 (0.0019)	5.034623 (0.0000)	4.726607 (0.0000)
Standardized Honda	6.841372 (0.0000)	5.196830 (0.0000)	3.453288 (0.0003)
Standardized King-Wu	6.841372 (0.0000)	5.196830 (0.0000)	4.211881 (0.0000)
Gourieroux, et al.*	--	--	33.70158 (0.0000)

Appendix 4.36 Hausman Test for Model 1

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	107.548256	4	0.0000

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LOG_FDI2	-0.013863	-0.002437	0.000024	0.0196
LOG_GDP	0.344089	0.567647	0.001969	0.0000
LOG_POP	1.738373	-0.195300	0.090263	0.0000
LOG_RE	0.006246	0.063324	0.009049	0.5485

Cross-section random effects test equation:
Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/24/20 Time: 23:58
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.030411	0.487659	4.163591	0.0001
LOG_FDI2	-0.013863	0.008505	-1.629866	0.1066
LOG_GDP	0.344089	0.048789	7.052643	0.0000
LOG_POP	1.738373	0.301424	5.767192	0.0000
LOG_RE	0.006246	0.095209	0.065602	0.9478

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.969149	Mean dependent var	9.453472
Adjusted R-squared	0.966437	S.D. dependent var	0.276428
S.E. of regression	0.050642	Akaike info criterion	-3.042372
Sum squared resid	0.233382	Schwarz criterion	-2.807906
Log likelihood	161.1186	Hannan-Quinn criter.	-2.947479
F-statistic	357.3329	Durbin-Watson stat	0.206321
Prob(F-statistic)	0.000000		

Appendix 4.37 Hausman Test for Model 2

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	99.295772	4	0.0000

** WARNING: estimated cross-section random effects variance is zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LOG FD	0.007533	0.063831	0.001343	0.1245
LOG GDP	0.296729	0.553351	0.001762	0.0000
LOG POP	1.858837	-0.164393	0.118642	0.0000
LOG RE	0.004346	0.070876	0.015982	0.5987

Cross-section random effects test equation:
Dependent Variable: LOG CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:11
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.020286	0.648141	3.117046	0.0024
LOG FD	0.007533	0.052983	0.142175	0.8873
LOG GDP	0.296729	0.045584	6.509502	0.0000
LOG POP	1.858837	0.345822	5.375120	0.0000
LOG RE	0.004346	0.126555	0.034337	0.9727

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.968255	Mean dependent var	9.453472
Adjusted R-squared	0.965465	S.D. dependent var	0.276428
S.E. of regression	0.051370	Akaike info criterion	-3.013820
Sum squared resid	0.240142	Schwarz criterion	-2.779355
Log likelihood	159.6910	Hannan-Quinn criter.	-2.918928
F-statistic	346.9544	Durbin-Watson stat	0.178728
Prob(F-statistic)	0.000000		

Appendix 4.38 Hausman Test for Model 3

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	128.583356	4	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
LOG__RE_FD_	-0.514994	0.100313	0.009875	0.0000
LOG POP FD	-0.174699	-0.249512	0.012284	0.4997
LOG GDP FD	0.560015	0.422309	0.001595	0.0006
LOG FDI FD	-0.019874	0.000138	0.000031	0.0004

Cross-section random effects test equation:
Dependent Variable: LOG_CO2
Method: Panel Least Squares
Date: 02/25/20 Time: 00:19
Sample: 1996 2015
Periods included: 20
Cross-sections included: 5
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.257263	0.351413	14.96035	0.0000
LOG RE FD	-0.514994	0.099546	-5.173429	0.0000
LOG POP FD	-0.174699	0.115971	-1.506407	0.1354
LOG GDP FD	0.560015	0.044114	12.69467	0.0000
LOG FDI FD	-0.019874	0.009879	-2.011799	0.0472

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.957954	Mean dependent var	9.453472
Adjusted R-squared	0.954258	S.D. dependent var	0.276428
S.E. of regression	0.059121	Akaike info criterion	-2.732786
Sum squared resid	0.318067	Schwarz criterion	-2.498321
Log likelihood	145.6393	Hannan-Quinn criter.	-2.637894
F-statistic	259.1648	Durbin-Watson stat	0.413162
Prob(F-statistic)	0.000000		

Appendix 4.39 Multicollinearity Test (VIF) for Model 1

Variance Inflation Factors
Date: 02/24/20 Time: 23:51
Sample: 1 100
Included observations: 100

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_FDI2	0.000101	694.3661	1.592755
LOG_GDP	0.000860	2015.907	2.025901
LOG_POP	0.001241	112.9706	1.116794
LOG_RE	3.33E-05	3.775490	1.280015
C	0.087857	1639.118	NA

Appendix 4.40 Multicollinearity Test (VIF) for Model 2

Variance Inflation Factors
Date: 02/25/20 Time: 00:04
Sample: 1 100
Included observations: 100

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG_FD	0.002933	199.1754	3.002078
LOG_GDP	0.000632	1503.038	1.510490
LOG_POP	0.001905	175.8586	1.738486
LOG_RE	6.86E-05	7.890974	2.675298
C	0.092263	1745.407	NA

Appendix 4.41 Multicollinearity Test (VIF) for Model 3

Variance Inflation Factors
Date: 02/25/20 Time: 00:15
Sample: 1 100
Included observations: 100

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LOG RE FD	7.91E-05	16.47206	1.687614
LOG POP FD	0.002693	556.0250	1.674683
LOG GDP FD	0.000811	1720.024	1.975179
LOG FDI FD	0.000153	840.3744	1.888304
C	0.097239	1203.609	NA

Appendix 4.42 Breusch-Godfrey Serial Correlation LM Test for Model 1

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	39.22975	Prob. F(2,93)	0.0000
Obs*R-squared	45.75978	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/20 Time: 21:36
Sample: 1 100
Included observations: 100
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_FDI2	-0.005268	0.007519	-0.700566	0.4853
LOG_GDP	0.009359	0.021854	0.428256	0.6695
LOG_POP	-0.009564	0.026337	-0.363149	0.7173
LOG_RE	-0.001820	0.004304	-0.422773	0.6734
C	0.020780	0.220857	0.094088	0.9252
RESID(-1)	0.667981	0.103449	6.457092	0.0000
RESID(-2)	0.017002	0.104075	0.163359	0.8706

R-squared	0.457598	Mean dependent var	6.58E-16
Adjusted R-squared	0.422604	S.D. dependent var	0.071718
S.E. of regression	0.054496	Akaike info criterion	-2.913947
Sum squared resid	0.276194	Schwarz criterion	-2.731585
Log likelihood	152.6973	Hannan-Quinn criter.	-2.840141
F-statistic	13.07658	Durbin-Watson stat	1.926169
Prob(F-statistic)	0.000000		

Appendix 4.43 Breusch-Godfrey Serial Correlation LM Test for Model 2

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	40.50553	Prob. F(2,93)	0.0000
Obs*R-squared	46.55512	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/20 Time: 21:37
Sample: 1 100
Included observations: 100
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG FD	0.042721	0.040422	1.056886	0.2933
LOG GDP	-0.007523	0.018626	-0.403930	0.6872
LOG POP	0.009828	0.032281	0.304450	0.7615
LOG RE	0.004087	0.006142	0.665405	0.5074
C	-0.025784	0.224553	-0.114826	0.9088
RESID(-1)	0.678575	0.103150	6.578510	0.0000
RESID(-2)	0.013924	0.103939	0.133960	0.8937

R-squared	0.465551	Mean dependent var	1.21E-16
Adjusted R-squared	0.431071	S.D. dependent var	0.071221
S.E. of regression	0.053720	Akaike info criterion	-2.942619
Sum squared resid	0.268387	Schwarz criterion	-2.760257
Log likelihood	154.1310	Hannan-Quinn criter.	-2.868814
F-statistic	13.50184	Durbin-Watson stat	1.927958
Prob(F-statistic)	0.000000		

Appendix 4.44 Breusch-Godfrey Serial Correlation LM Test for Model 3

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	51.90159	Prob. F(2,93)	0.0000
Obs*R-squared	52.74467	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/26/20 Time: 21:38
Sample: 1 100
Included observations: 100
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG RE FD	0.001785	0.006184	0.288714	0.7734
LOG POP FD	0.020228	0.036108	0.560211	0.5767
LOG GDP FD	0.013504	0.019936	0.677376	0.4998
LOG FDI FD	-0.005843	0.008657	-0.674982	0.5014
C	-0.142707	0.217224	-0.656957	0.5128
RESID(-1)	0.762771	0.103356	7.380012	0.0000
RESID(-2)	-0.043781	0.103969	-0.421098	0.6747

R-squared	0.527447	Mean dependent var	-1.17E-16
Adjusted R-squared	0.496959	S.D. dependent var	0.088048
S.E. of regression	0.062449	Akaike info criterion	-2.641519
Sum squared resid	0.362683	Schwarz criterion	-2.459157
Log likelihood	139.0759	Hannan-Quinn criter.	-2.567713
F-statistic	17.30053	Durbin-Watson stat	1.899446
Prob(F-statistic)	0.000000		

Appendix 4.45 Heteroskedasticity Test for Model 1

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.775383	Prob. F(4,95)	0.1402
Obs*R-squared	6.955362	Prob. Chi-Square(4)	0.1383
Scaled explained SS	9.270509	Prob. Chi-Square(4)	0.0547

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/24/20 Time: 23:54
Sample: 1 100
Included observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024914	0.035064	0.710519	0.4791
LOG FDI2	-0.000769	0.001190	-0.646317	0.5196
LOG GDP	0.001566	0.003469	0.451478	0.6527
LOG POP	-0.009786	0.004167	-2.348204	0.0209
LOG RE	-0.000562	0.000682	-0.823612	0.4122

R-squared	0.069554	Mean dependent var	0.005092
Adjusted R-squared	0.030377	S.D. dependent var	0.008795
S.E. of regression	0.008661	Akaike info criterion	-6.611307
Sum squared resid	0.007126	Schwarz criterion	-6.481048
Log likelihood	335.5653	Hannan-Quinn criter.	-6.558589
F-statistic	1.775383	Durbin-Watson stat	1.055076
Prob(F-statistic)	0.140182		

Appendix 4.46 Heteroskedasticity Test for Model 2

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	2.545358	Prob. F(4,95)	0.0444
Obs*R-squared	9.679877	Prob. Chi-Square(4)	0.0462
Scaled explained SS	14.00015	Prob. Chi-Square(4)	0.0073

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/25/20 Time: 00:06
Sample: 1 100
Included observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.022835	0.036623	0.623515	0.5344
LOG FD	0.009772	0.006529	1.496659	0.1378
LOG GDP	-0.002110	0.003032	-0.696031	0.4881
LOG POP	-0.006250	0.005263	-1.187610	0.2379
LOG RE	0.000594	0.000999	0.594966	0.5533

R-squared	0.096799	Mean dependent var	0.005022
Adjusted R-squared	0.058769	S.D. dependent var	0.009036
S.E. of regression	0.008766	Akaike info criterion	-6.587134
Sum squared resid	0.007300	Schwarz criterion	-6.456876
Log likelihood	334.3567	Hannan-Quinn criter.	-6.534416
F-statistic	2.545358	Durbin-Watson stat	1.030497
Prob(F-statistic)	0.044442		

Appendix 4.47 Heteroskedasticity Test for Model 3

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

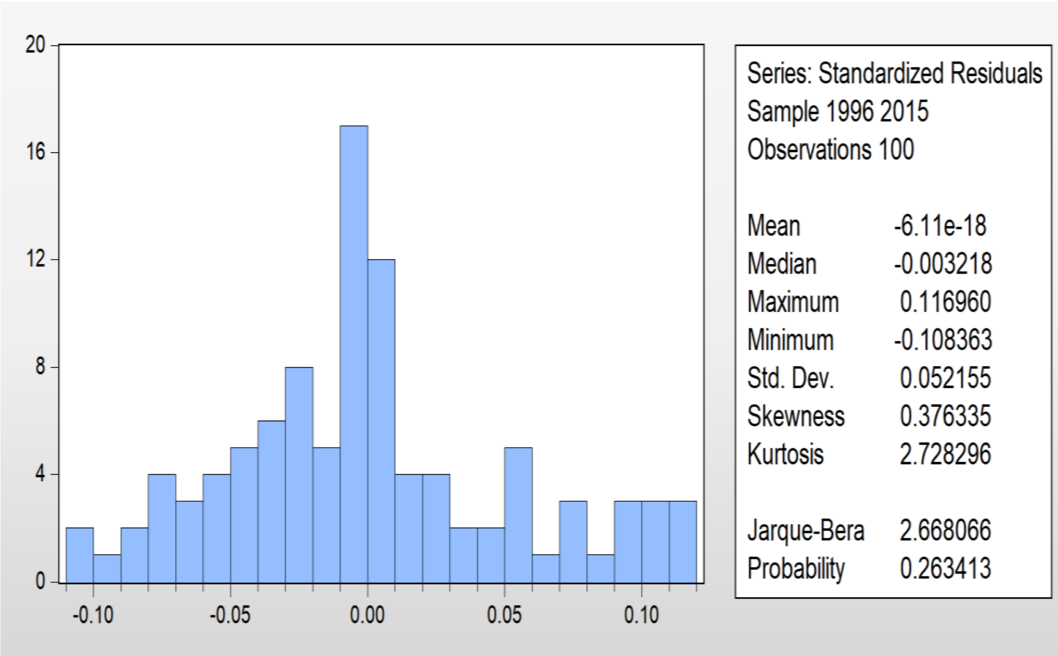
F-statistic	1.568920	Prob. F(4,95)	0.1889
Obs*R-squared	6.196630	Prob. Chi-Square(4)	0.1849
Scaled explained SS	12.37618	Prob. Chi-Square(4)	0.0148

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/25/20 Time: 00:16
Sample: 1 100
Included observations: 100

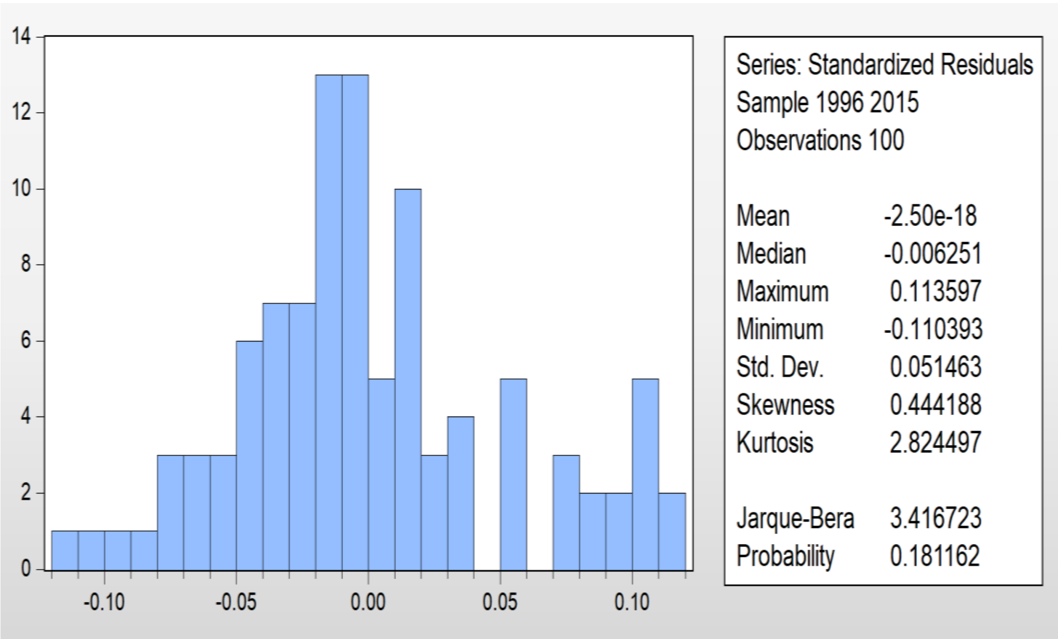
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.026044	0.055664	-0.467876	0.6409
LOG RE FD	-0.003242	0.001588	-2.041890	0.0439
LOG POP FD	-0.011408	0.009263	-1.231558	0.2212
LOG GDP FD	0.006956	0.005082	1.368655	0.1743
LOG FDI FD	8.64E-05	0.002208	0.039144	0.9689

R-squared	0.061966	Mean dependent var	0.007675
Adjusted R-squared	0.022470	S.D. dependent var	0.016228
S.E. of regression	0.016045	Akaike info criterion	-5.378172
Sum squared resid	0.024456	Schwarz criterion	-5.247913
Log likelihood	273.9086	Hannan-Quinn criter.	-5.325454
F-statistic	1.568920	Durbin-Watson stat	0.811838
Prob(F-statistic)	0.188906		

Appendix 4.48 Normality Test for Model 1



Appendix 4.49 Normality Test for Model 2



Appendix 4.50 Normality Test for Model 3