THE IMPACTS OF ECONOMIC GROWTH, FINANCIAL DEVELOPMENT AND ENERGY CONSUMPTION ON CO_2 EMISSIONS IN FOUR ASEAN COUNTRIES

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วิทยานิพนธ์ฉบับนี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบของการเติบโตทางเศรษฐกิจ การบริโภคพลังงาน และการพัฒนาทางการเงินที่มีต่อการปล่อยก๊าซคาร์บอนไดออกไซด์ในสี่ประเทศอาเซียน และทดสอบความสัมพันธ์แบบเส้นโค้งสิ่งแวดล้อมของคุซเน็ตส์ (Environment Kuznets Curve: EKC) ว่าปรากฏในกลุ่มประเทศเหล่านี้หรือไม่ ในระยะยาว การเติบโตทางเศรษฐกิจและการบริโภคพลังงานไม่ส่งผลต่อการปล่อยก๊าซคาร์บอนไดออกไซด์ในประเทศมาเลเซีย ฟิลิปปินส์และไทย แต่ในประเทศสิงคโปร์ กลับพบว่า การเติบโตทางเศรษฐกิจและการบริโภคพลังงานส่งผลในทางบวกต่อการปล่อยก๊าซคาร์บอนไดออกไซด์อย่างมีนัยสำคัญ สำหรับในระยะสั้น ผลการศึกษาพบว่า การเติบโตทางเศรษฐกิจส่งผลต่อการปล่อยก๊าซคาร์บอนไดออกไซด์ในประเทศฟิลิปปินส์ สิงคโปร์และไทย ส่วนการบริโภคพลังงานมีความสัมพันธ์ในทางบวกต่อการปล่อยก๊าซคาร์บอนไดออกไซด์ด้วยเช่นกันซึ่งพบในประเทศฟิลิปปินส์ สิงคโปร์ และมาเลเซีย อย่างไรก็ตาม การพัฒนาทางการเงินไม่ส่งผลต่อการปล่อยก๊าซคาร์บอนไดออกไซด์อย่างมีนัยสำคัญทางสถิติในสี่ประเทศอาเซียนทั้งในระยะสั้นและระยะยาว นอกจากนี้ ผลการศึกษาพบว่า เส้นโค้งสิ่งแวดล้อมของคุซเน็ตส์ (Environment Kuznets Curve: EKC) แสดงผลเฉพาะประเทศสิงคโปร์เท่านั้น โดยค่าความยืดหยุ่นในระยะยาวของแต่ละตัวแปรที่ส่งต่อการปล่อยก๊าซคาร์บอนไดออกไซด์สูงกว่าค่าความยืดหยุ่นในระยะสั้น

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This study investigates the impacts of economic growth, financial development and energy consumption on CO_2 emissions in 4 ASEAN countries, which are Malaysia, Philippines, Singapore and Thailand. It also tests whether an Environment Kuznets Curve (EKC) relationship hold in these countries. In the long run, there is no evidence that economic growth and energy consumption can lead to higher level of CO_2 emissions in Malaysia, Philippines and Thailand, while in Singapore both economic growth and energy consumption are positive and statistically significant with respect to CO_2 emissions. In the short run, economic growth is a major contributor to CO_2 in Philippines, Singapore and Thailand. Energy consumption is also positively related to CO_2 emissions in Philippines, Singapore and Malaysia. However, financial development is statistically insignificant in all 4 countries in both short run and long run. The EKC is valid only in the case of Singapore and its long-run elasticities of each variable with respect to CO_2 emissions are higher than the short-run elasticities.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey–Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
ASEAN	Association of Southeast Asian Nations
CO_2	Carbon Dioxide
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum of Square
ECM	Error Correction Model
EKC	Environmental Kuznets Curve
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HQC	Hannan–Quinn Information Criterion
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
R&D	Research and Development
SBC	Schwarz-Bayesian Information Criterion
UCB	Upper Critical Bound
WDI	World Development Indicators

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CHAPTER I
INTRODUCTION

1.1 Background

Global warming, air pollution and extreme climate changes due to increasing CO_2 emissions and other greenhouse gas emissions has become a global concern. Whether economic growth will have an effect on CO_2 emissions has always been a hot topic among scholars and researchers.

It has been investigated since the 1990s after Grossman and Krueger (1994) provide empirical evidence that environmental pollutants rise in early stage of economic development and decrease in higher income level as economy develops. This inverted U-shaped relationship between CO_2 emissions and GDP per capita is called Environmental Kuznets Curve (EKC). The cause of the upswing of inverted U is simply that greater output per capita generates more emissions. However, the cause of the downswing can be explained in various ways. The conventional explanation is that consumers at higher income level demand higher environmental quality, richer government have more resource and motivation to enforce regulations to prevent pollutions, and more technological advanced producers are better to control emissions.

Greenhouse gases (GHG) absorb and re-emit heat, and thereby make the earth warmer. The major greenhouse gas emitted by human activities are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and other fluorinated gases (Brander and Davis, 2012). In terms of the impact of global warming, CO_2 is believed to be the most important greenhouse gas. In United States, CO_2 alone accounts for 81% of greenhouse gas in 2014, followed by methane (11%) and N_2O (6%). [1] Therefore, CO_2 can considered as an important indicator of global warming and environmental degradation.

In this study, I attempt to test the Environmental Kuznets Curve in 4 ASEAN countries, namely Malaysia, Philippines, Singapore and Thailand through time series approach. Due to different demographic factors, economic background and policies among these 4 ASEAN countries. panel data analysis miss the characteristics of specific country, thus it may be not suitable to analyze effects of each factors in different countries (Solow, 2001). Instead, the country-specific study allows us to capture the complexity of economic and historical background of each country.

1.2 ASEAN Context

The Association of Southeast Asian Nations (ASEAN) is a regional organization in Southeast Asia that promotes both intergovernmental cooperation and economic integration amongst its ten member states. It comprises of ten countries：Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

ASEAN is one of the fastest growth regions in the world. According to Sandhu et al. (2012), between 1971 and 2009, there is an averagely 1.9% increase per year in the population in ASEAN, while in the same period, economy grows much faster, at more than 5% per year. Rapid growth in industrialization and urbanization in this area increases the energy consumption substantially, and hence increases the CO_2 intensity of the economies. During the same period, the energy consumption

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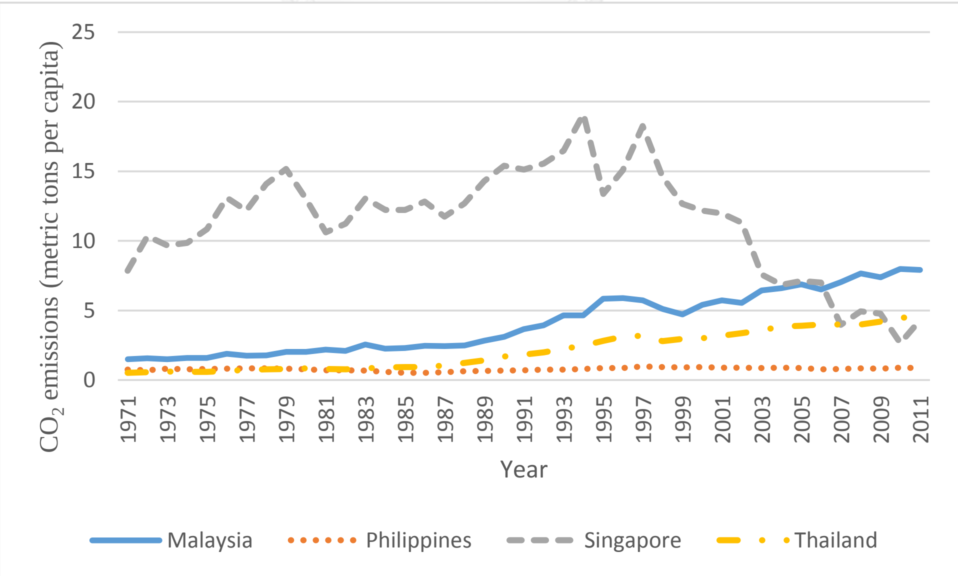
[1] The value cited are from Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014* (April 2016), available at https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf

increases dramatically, which has result in increased CO_2 emissions at an annual average rate of around 6.2%.

In this paper, Malaysia, Philippines, Singapore and Thailand are chosen among 10 member countries. The reason of studying these 4 selected ASEAN countries is because that these countries have been among the highest growth economies in the world over the last 3 decades. Another reason to study 4 selected ASEAN countries is due to data availability and accessibility.

As shown in Figure 1.1, between 1971 and 2011, Malaysia and Thailand show an upward trend in CO_2 emissions per capita, especially for Malaysia the CO_2 emissions increased from 1.49 metric tons per capita in 1971 to 7.99 metric tons per capita in 2011. CO_2 emissions per capita in Singapore show an upward trend before 1995, but after 1997 it decreases dramatically. In Philippines, CO_2 emissions fluctuates from time to time.

Figure 1.1 CO_2 Emissions in 4 ASEAN Countries

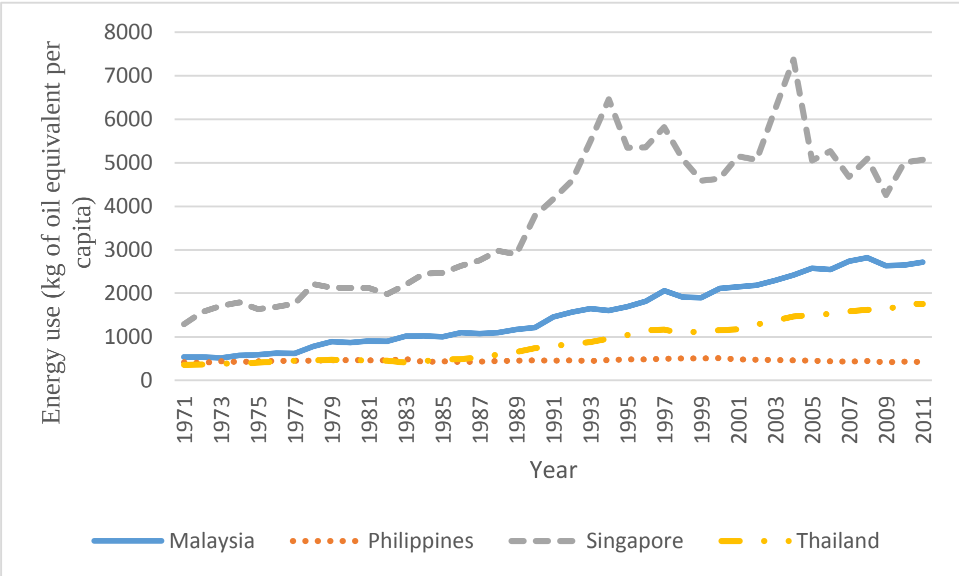


Data source: World Bank [2]

[2] All the data in this study are from World Development Indicators by World Bank, available online at http://data.worldbank.org/data-catalog/world-development-indicators

As shown in Figure 1.2, energy use per capita between 1971 and 2011 in the 4 ASEAN countries generally have an upward trend except Philippines, which tends to be stable during the period. Energy use per capita in Singapore firstly increases and apparently declines after 1993.

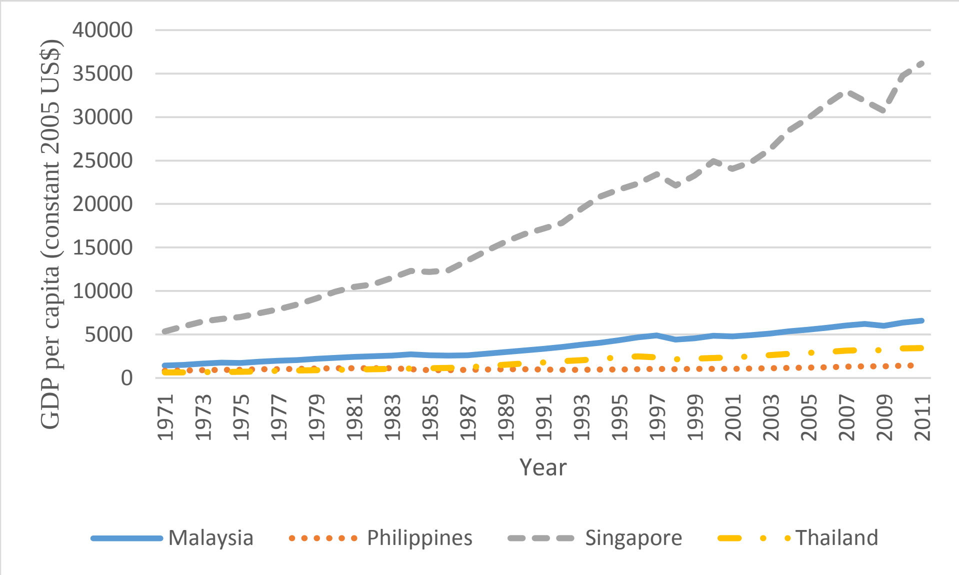
Figure 1.2 Energy Use in 4 ASEAN Countries



Data source: World Bank

Figure 1.3 shows the pattern of GDP per capita in 4 countries. Between 1971 and 2011, GDP per capita in Singapore has apparently exceeded other countries. GDP per capita in other countries have also increased dramatically. GDP per capita in Thailand has increased from 632 USD in 1971 to 3,428 USD in 2011.

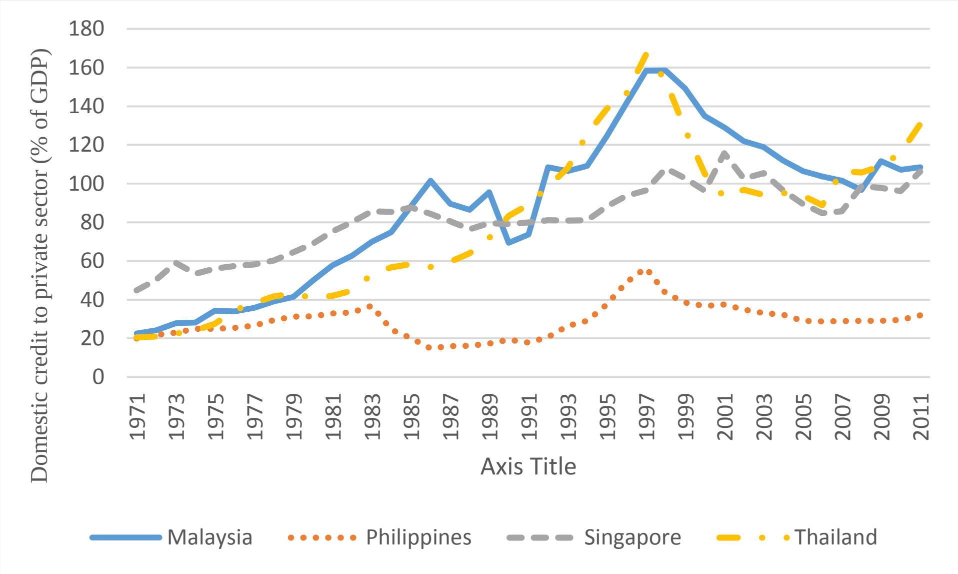
Figure 1.3 GDP per capita in 4 ASEAN Countries



Data source: World Bank

To measure the financial development, domestic credit to the private sector is applied. As shown in Figure 1.4, domestic credit to private sector all reach its peak in the year 1997 in all country cases and then decline due to financial crisis.

Figure 1. 4 Domestic Credit to Private Sector in 4 ASEAN Countries



Data source: World Bank

1.3 Objectives of the Study

In this paper, the long-run equilibrium and short-run dynamics among CO_2 emissions, GDP per capita, financial development, and energy consumption is explored by Autoregressive Distributed Lag (ARDL)[3] test.

(i) The main objective is to study long-run equilibrium relationship and short-run dynamics among CO_2 emissions, economic growth, financial development and energy consumption, and

(ii) The second objective is to test the validity of Environmental Kuznets Curve (EKC).

1.4 Significance of the Study

The main reason for studying CO_2 emissions is that they play a key role in the

[3] More description and explanation of ARDL test is explored in Chapter III

current debate on environmental issues. Many studies believe economic development is closely related to energy consumption that leads to the higher CO_2 emissions. But it is also equally likely that better economic performance can increase the use of greener technology and fuel-efficiency technology, which finally reduce CO_2 emissions. This is particularly important for developing countries in ASEAN, who are under pressure to accelerate the economic growth when facing the problem of environmental degradation.

So far majority of the early studies limit their analysis by only linking to the energy consumption and economic development. The role of the financial development is less explored especially in ASEAN, although financial development increasingly plays an important role in the development process in this region. The Autoregressive Distributed Lag (ARDL) bounds testing approach is applied to investigate the cointegration for a long-run and short-run relationship among CO_2 emissions, economic development, financial development and energy consumption. Compared to the previous studies, this study has taken financial factor into consideration under ASEAN context. The issue is particularly important and understanding the effects of economic growth and financial development on CO_2 emissions allows the policy maker to derive proper policies.

In addition, very few papers have analyzed the relationship among economic growth, energy consumption, financial development and CO_2 emissions in the case of ASEAN countries. This research may help policy maker in making a decision when facing the "development-pollution" nexus. Because depending on whether there is negative or positive influence of economic and financial development on CO_2 emissions, policy recommendations will differ.

1.5 Scope of the Study

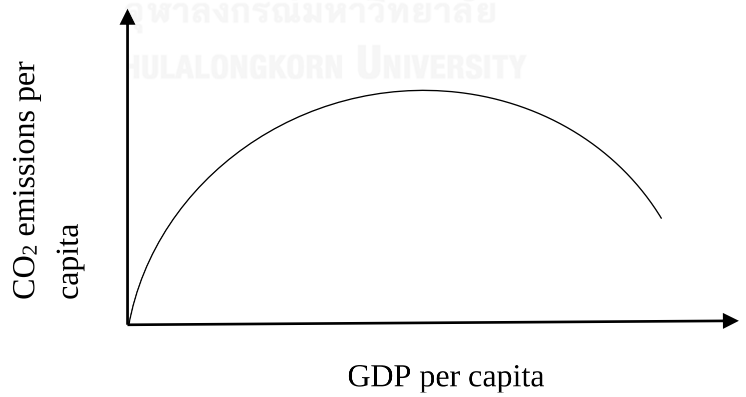
The study examines the impact of energy consumption, economic growth and financial development on CO_2 emissions in the period of 1971 to 2011 in 4 ASEAN member countries, namely Malaysia, Philippine, Singapore and Thailand. A country-specific study is preferred to cross-sectional study because empirical studies account for the aggregate level may not be able to capture and account for the complexity of economic environment and specific characteristics of each country.

CHAPTER II
LITARATURE REVIEW

2.1 Environmental Kuznets Curve (EKC)

The Environmental Kuznets Curve (EKC) hypothesis proposes that there is an inverted U-shape relationship (See Figure 2.1) between GDP per capita and CO_2 emissions per capita. That is, CO_2 emissions rise in early stage of economic growth and go down after some certain point in later stage of growth. This inverted-U relationship derives its name from a research of Kuznets (1955) which show a similar relationship between equality and income per capita. The logic behind is that the industrial development initially leads to higher CO_2 emissions but the emissions eventually decline as a by-product of greener technology and increasing fuel efficiency (Holtz-Eakin and Selden, 1993).

Figure 2.1 Environmental Kuznets Curve (EKC)



The EKC hypothesis suggests that the economic growth will initially lead to a gradual degradation of environment, and after a certain level of growth, the environmental pollution decreases when economic growth increase. This hypothesis is first proposed and tested by Grossman and Krueger (1994). More recently, Ang (2008), Ang (2009) and Ozturk and Acaravci (2010) examine the time series dynamics between economic development and CO_2 emissions to infer the direction of causality. For example, Ang (2009) finds a long-run relationship between energy consumption, output and CO_2 emissions in China. The causality test supports the argument that in the long-run economic development can exert a positive causal influence both on energy consumption and CO_2 emissions. Conversely, Dinda and Coondoo (2006) use panel data and provide ambiguous results about income per capita and CO_2 emissions. Their results indicate the presence of cointegration in Africa, East Europe, West Europe, but not in Central America, America and Asia. Recently, many studies test the Environmental Kuznets Curve using cross-sectional data, for example, Pao et al. (2011) for Russia; Pao and Tsai (2011) for BRIC[4] countries and Lean and Smyth (2010) for ASEAN. Other recent studies use time series data and validate the Environmental Kuznets Curve in different countries, for instance, Ang (2007) for France, Jalil and Mahmud (2009) for China, and Ozturk and Acaravci (2010) for Turkey. Table 2.1 below provides a summary of selected previous empirical studies on CO_2 emissions, energy consumption and economic growth.

[4] BRIC countries refers to a group of 4 leading developing countries: Brazil, Russia, India and China.

Table 2.1 Summary of Empirical Studies on CO_2 Emissions, Energy Consumption and Economic Growth

Author	Country	Period	Results
Ang (2007)	France	1960-2000	• Long-run positive relationship between economic growth and energy consumption • Long-run positive relationship between economic growth and CO_2 emissions • Short-run uni-directional causality running from energy consumption to economic growth
Ang (2008)	Malaysia	1971-1999	• Positive relationship between CO2 emissions and energy use in the long-run
Jalil and Mahmud (2009)	China	1971-2005	• Long-run positive relationship between income and CO_2 emissions • Consistent with EKC
Lean and Smyth (2010)	ASEAN	1980-2006	• Long-run positive relationship between electricity consumption and CO_2 emissions • Non-linear relationship between emissions and real output • Consistent with EKC
Ozturk and Acaravci (2010)	Turkey	1960-2007	• Neither carbon emissions per capita nor energy consumption per capita cause real GDP per capita
Pao and Tsai (2011)	BRIC	1971-2005	• Long-run positive relationship between energy consumption and CO_2 emissions • Consistent with EKC
Pao et al. (2011)	Russia	1990-2007	• Energy is a more important determinant of emissions than output. • Bidirectional strong causality relationship between emissions, energy use and output

2.2 Financial Development and CO_2 Emissions

Financial development is also an important factor in affecting the CO_2 emissions. Financial system allowed resources to be allocated across space and time (Crane et al., 1995). The 5 key functions of a financial system according to Levine (2005) are: "(i) producing information ex ante about possible investments and allocate capital; (ii) monitoring investments and exerting corporate governance after providing finance; (iii) facilitating the trading, diversification, and management of risk; (iv) mobilizing and pooling savings; and (v) easing the exchange of goods and services." Therefore, financial development is considered as improvement of these 5 functions of financial system. In order to understand the relationship between financial development and CO_2 emissions, it is important to find an indicator to measure the financial development. However, it is not easy to measure as financial development has many dimensions. Previous empirical studies mostly use quantitative indicators such as ratio of financial institutions assets to GDP or ratio of liquidity of ratio of GDP. However, the most common indicator is domestic credit to private sectors.

Regarding to the relationship between financial development and CO_2 emissions. There are basically two arguments. One believed there is negative relationship as better financial system can increase research and development (R&D) and also increase the energy efficiency. But it is also considered that financial development can lead higher level of outputs, which require more productive activities and energy use, and thus increase CO_2 emissions.

On the one hand, financial development may help to reduce CO_2 emissions. It helps to stimulate technological innovation in clean and fuel-efficiency energies, and hence reduce emissions. It can also generally promote research and development (R&D) activities that can improve economic activities and finally reduce CO_2 emissions (Frankel and Romer, 1999).

Tamazian et al. (2009) and Claessens and Feijen (2007) argue that financial development may help reduce CO_2 emissions through increasing energy efficiency and technological innovation. Tamazian et al. (2009) establish a link between financial development and CO_2 in the BRIC countries. Their study suggests that the well-developed financial sector can provide better investment environment and economic growth at lower cost for environmental projects. Furthermore, Claessens and Feijen (2007) argue that a well-functioning financial sector is necessary for the carbon trading, which is a mechanism that provides the incentive to mitigate the greenhouse gas emissions. Besides, Tamazian and Rao (2010) document that since environmental sectors are believed to be public-sectors, financing in the public or governmental sectors plays a vital role for environmental degradation. Hence, financial services may be mobilized for eco-friendly projects. According to Claessens and Feijen (2007), financial development improves environmental quality through good governance practices. Furthermore, Tadesse (2005) documents that improvement of financial system prompts technological innovations through risk sharing and capital mobilization.

Jalil and Feridun (2011) investigate the impact of energy consumption, economic growth and financial development on CO_2 emissions in China using Autoregressive Distributed Lag (ARDL) model. The results of their study reveal a negative sign for the coefficient of financial development, suggesting that financial development in China has not taken place at the expense of environmental degradation. Therefore financial development has led to a decrease in CO_2 emissions. Similarly, Shahbaz et al. (2013) also find the same result in the case of Indonesia.

On the other hand, financial development may increase emissions through scale effects of economic activities. Firstly, financial markets provide financing channels and help lower the financing cost for enterprises as well as disperse operating risk. Thus, enterprise can buy more installations and invest more projects, and thus increase energy consumption and CO_2 emissions. Secondly, sound financial structure and policy may attract foreign direct investment so as to boost economic growth and CO_2 emissions.

Dasgupta et al. (2006) and Zhang (2011) argue that financial development can be harmful to environment by increasing the CO_2 emissions from the growth of economic activities. Sadorsky (2010) investigates the impact of financial development in 22 emerging countries on energy consumption using a panel data model. His study suggests that financial development in these countries significantly increase the energy consumption. His study for Central and Eastern European countries also shows the same results (Sadorsky, 2011). Zhang (2011) explores the impact of financial development on CO_2 emissions in China, and argues that financial development in China plays a vital role for increasing of CO_2 emissions. Table 2.2 provides a summary of selected previous empirical studies on CO_2 emissions, energy consumption, economic growth and financial development.

Table 2.2 Summary of Empirical Studies on Carbon Emissions, Energy Consumption and Financial Development

Author	Country	Period	Results
Tamazian et al. (2009)	BRIC	1992-2004	• Negative relationship between financial development and CO_2 emissions • Consistent with EKC
Tamazian and Rao (2010)	24 transition economies	1993-2004	• Negative relationship between financial development and CO_2 emissions • Consistent with EKC
Jalil and Feridun (2011)	China	1953-2006	• Long-run negative relationship between financial development and CO_2 emissions • Consistent with EKC
Shahbaz et al. (2013)	Indonesia	1975-2011	• Negative relationship between financial development and CO_2 emissions
Dasgupta et al. (2006)	Korea	1993-2000	• Positive relationship between financial development and CO_2 emissions
Sadorsky (2010)	Emerging market economies	1980-2007	• Positive relationship between financial development and energy consumption
Sadorsky (2011)	Central and Eastern European countries	1996-2006	• Positive relationship between financial development and energy consumption
Zhang (2011)	China	1980-2009	• Positive relationship between financial development and CO_2 emissions

2.3 Energy Consumption, Economic Development and CO_2 Emissions

Economic development is believed to have a close relationship with energy use, because higher level of economic development requires larger scale of productive activities that expects more energy consumed. At the same time, increase of energy efficiency (which may lead to lower level of energy use) also requires higher level of economic development (Ang, 2008). Furthermore, Soytas et al. (2007) and Halicioglu (2009) find that energy consumption is the main factor for causing CO_2 emissions.

2.4 Others Factors Affecting CO_2 Emissions

International trade is one of the most important factors that can explain EKC. The Hecksher-Ohlin trade theory suggests that, under free trade, developing countries specialize in producing labor intensive goods, while the developed countries instead specialize in producing capital intensive goods. This implies that pollution is generated in producing the goods and is also related in consuming in other countries. For example, when demand of one product in import country increases, the export country will produce more, and this leads to increasing production activities and pollution. Therefore, international trade is believed to be one of the most important factors that can affect the CO_2 emissions.

Various studies suggest that free trade has the contradictory impacts on environment. Birdsall and Wheeler (1993) find that international trade can increase cleaner industry which will reduce CO2 emissions in Latin America countries. It can reduce environmental degradation through composition effect or technique effect (Cadoret and Tran, 2015).

By contrast, Lee and Roland-Holst (1997) provide the result that international trade between Indonesia and outside world has increased the CO_2 emissions in Indonesia. Environmental degradation can increase through the scale effects as increasing trade volume raise the production activities, which increases CO_2 emissions.

Economic literatures usually argue that liberalized trade creates the opportunity for the country to grow. That is, trade leads to higher real income per capita. Moreover, higher real income generates cleaner production technique (technique effect) and it can also have an effect on the composition of a country's mix of clean/dirty industry (composition effect).

Moreover, developing countries can provide a "pollution haven" (Eskeland and Harrison, 2003) if they set environmental standards below their efficiency levels to attract foreign investment. The pollution haven hypothesis refers to the possibility that multinationals, especially those engaged in highly polluting activities, may relocate to countries with lower environmental regulations. In this way, developing countries are more attractive for foreign investment, especially in highly polluted industries. The empirical evidence remains controversial in regarding to FDI and CO_2 emissions. Acharyya (2009) for India and Jia-yu (2011) for China support the positive relationship between FDI and CO_2 emissions. But Shaari et al. (2014) find that FDI has no effect on CO_2 emissions in 15 developing countries.

CHAPTER III
METHODOLOGY

3.1 Model Specification

The objective of this study is to analyze the impacts of economic growth, financial development, and energy consumption on CO_2 emissions in the case of 4 ASEAN countries. In doing so, many approaches are applied to test the relationship between energy consumption, economic growth, and CO_2 emissions in previous studies. For example, Ang (2007), Ang (2008), Halicioglu (2009) and Shahbaz et al. (2013) apply single equation model to study the impacts of energy consumption, economic growth on CO_2 emissions. Moreover, Talukdar and Meisner (2001) , Tamazian et al. (2009), and Jalil and Feridun (2011) add financial development as a potential determinant of CO_2 emissions in the single equation.

Following these studies, energy consumption per capita, GDP per capita, financial development indicator and CO_2 emissions per capita is applied in a single multivariate framework.

A log linear econometric model is as follows:

$$\mathrm{co}_t = \beta_0 + \beta_1 \mathrm{e}_t + \beta_2 \mathrm{y}_t + \beta_3 \mathrm{fd}_t + \varepsilon_t \qquad (1)$$

co_t is CO_2 emissions per capita , e_t is the energy use per capita, y_t is the income per capita, fd_t is the financial development, and ε_t is the error term.

To test the existence of Environmental Kuznets Curve, this study includes the squared term of y_t . Because the squared term ${\mathrm{y}_t}^2$ produces the inverted-U behavior. If the EKC holds, it is expected that the coefficient of y_t should be positive and ${\mathrm{y}_t}^2$ should be negative, respectively.

The validation of EKC curve shows whether the ASEAN economy is attaining growth at the cost of environment. Accordingly, a second model is specified as follows:

$$co_t = \beta_0 + \beta_1 e_t + \beta_2 y_t + \beta_3 y_t^2 + \beta_4 fd_t + \varepsilon_t \quad (2)$$

All the definitions remain the same.

3.2 Variables and Data

Following variables are used in Equations (1) and (2) in this paper.

co_t is CO_2 emissions measured by metric tons per capita. CO_2 emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

e_t is energy consumption (kg 14 of oil equivalent) per capita. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

y_t is real GDP per capita for economic growth.

fd_t is financial development proxied by real domestic credit to private sector per capita. According to World Bank, domestic credit to private sector refers to "financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. The financial corporations include monetary authorities and deposit money banks, as well as other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other financial corporations are finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies." Domestic credit to the private sector (% of GDP) is multiplied by GDP series to convert it into constant 2005 dollar amount. The data transformation are as follows:

fd_t = GDP per capita (constant 2005 US$)*domestic credit to private sector (% of GDP)

The annual data on real GDP per capita, energy consumption (kg of oil equivalent) per capita, domestic credit to the private sector as share of GDP and CO_2 emissions (metric tons per capita) in Malaysia, Philippines, Singapore and Thailand has been collected from World Development Indicators by World Bank. Other ASEAN member countries do not have a complete set of all the series and thus not selected for the study. The data sample of the study is 1971-2011. All variables are employed with their logarithms with base 10 to reduce heteroskedasticity and to obtain the growth rate of the relevant.

3.3 Autoregressive Distributed Lag (ARDL) Bounds Testing

The empirical goal is to estimate the impacts of per capita energy consumption, per capital GDP, square of per capita GDP, financial development on CO_2 emissions.

The ARDL bounds testing approach is applied. This approach is developed by Pesaran and Shin (1998) and Pesaran et al. (2001). Compared with other approaches, the ARDL approach has a number of advantages. Firstly, it can be applied without the classification of variables into I(0), I(1) (Pesaran and Pesaran, 1997). Secondly, it allows that the variables may have different optimal lags. Thirdly, the error correction model (ECM) is computed from the ARDL specification via a simple linear transformation, which integrates short-run adjustments with long-run equilibrium without losing long-run information. Fourthly, according to Pesaran and Shin (1998) the small sample properties ARDL approach are superior to those of the Johansen and Juselius (1990) cointegration techniques. Finally, endogeneity is no longer a problem in the ARDL approach because it is free of residual correlation. As Pesaran and Shin (1998) demonstrate, the appropriate lags in the ARDL approach are correct for both serial correlation and endogeneity.

However, the critical bounds test developed by Pesaran et al. (2001) is on the assumption that all variables are stationary of order I(0) or I(1), so it is necessary to ensure that none of the variables is integrated at an order of I(2) or beyond. For this reason, Augmented Dickey Fuller (ADF) test is applied.

The ARDL bounds testing approach basically has two steps to estimate long-run relationship. The first step is to investigate long-run relationship among all variables in the equation. By doing so, Equation (3) is specified as follows:

$$\Delta \mathrm{co_t} = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta \mathrm{co_{t-i}} + \sum_{i=1}^{p} \delta_i \Delta \mathrm{e_{t-i}} + \sum_{i=1}^{p} \mu_i \Delta \mathrm{y_{t-i}} + \sum_{i=1}^{p} \rho_i \Delta \mathrm{y^2}_{\mathrm{t-i}} + \sum_{i=1}^{p} \theta_i \Delta \mathrm{fd_{t-i}} + \lambda_1 \mathrm{co_{t-1}} + \lambda_2 \mathrm{e_{t-1}} + \lambda_3 \mathrm{y_{t-1}} + \lambda_4 \mathrm{y^2}_{\mathrm{t-1}} + \lambda_5 \mathrm{fd_{t-1}} + \mathrm{u_t} \tag{3}$$

$\mathrm{u_t}$ is the white noise and Δ is the first difference operator. The terms with summation signs represent the error correction dynamics, while the remaining part of equation with λ_t corresponds to the long-run relationship. The bounds testing procedure is based on the joint F-statistics that is tested the null of no cointegration $\mathrm{H_0}: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$. This indicates the existence of long-run relationship.Contrarily, the alternative hypothesis of $\mathrm{H_1}$ is $\lambda_r \neq 0$, r = 1,2,3,4.

The calculated F-statistics is compared with two sets of critical values reported by Pesaran et al. (2001). The upper critical bound (UCB) assumes that all variables are I(1). The lower critical bound assumes that all variables are I(0). If the calculated F-statistics lies above the upper critical value, the null hypothesis of no cointegration will be rejected, indicating cointegration. If the calculated F-statistics lies below the lower value, the null hypothesis cannot be rejected. If it lies between the bounds, the test is inconclusive. In such situation, the long-run relationship can be examined through error correction term. However, Narayan (2005) argues that existing critical values, which are based on large sample size, cannot be used for small sample size. Thus, Narayan

(2005) regenerates the set of critical values for the limited data ranging from 30-80 observations by using the Pesaran et al. (2001) GAUSS code. With the small sample size of annual data, the critical values of Narayan (2005) is applied.

The modified ARDL approach estimates $(p + 1)^k$ number of regression in order to obtain optimal lag length for each variable, where ‘p’ is the maximum number of lags to be used and ‘k’ is the number of variables in the model. Therefore, it is necessary to choose the appropriate number of lags in the model. The lag order of the variables can be selected through R-squared, Schawrtz-Bayesian criteria (SBC), Hannan-Quinnn Criterion (HQC) and Akaike’s information criteria (AIC). The SBC selects the smallest possible lag length while AIC is employed to select maximum relevant lag length. The long-run relationship among variables can be estimated after the selection of optimal lags by AIC or SBC criterion.

3.4 Robustness Checks

To ensure the goodness of fit of the model, the diagnostic and stability test are also conducted. Moreover, due to the structural changes in ASEAN economy it is likely that the time series data may be subject to some structural breaks. The structural breaks may be due to the first and second oil shocks in 1973-1975 and 1979-1980, respectively, the commodity crisis (1985-1986) and the Asian financial crisis (1997-1998) (Ling et al., 2013). For this reason, the stability of the short-run and long-run coefficients are checked through the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests proposed by (Brown et al., 1975).

3.5 Expected Signs

The expected signs of determinants of CO_2 emissions are summarized in Table 3.1.

Table 3.1 Expected Signs of Variables

Variable	Expected signs	Reason for expected signs
e	+	Growth of energy consumed leads to increasing CO_2 emissions.
y	+/-	(+) Growth of GDP from industrialization, results in growth in CO_2 emissions. (-) Growth of income makes society concern more on environmental issues, and companies may also apply greener technology and increase of fuel efficiency.
fd	+/-	(+) Better financial environment will attract more investment and finally more production and carbon emissions. (-) Financial development offers more opportunities for R&D and also transfer of greener technology.

Environmental Kuznets Curve (EKC) hypothesis: Equation (3) is specified to test the validity of EKC curve in case of ASEAN. Under the EKC hypothesis, the long-run elasticity estimates of per capita CO_2 emissions with respect to GDP per capita is expected to be higher than 0 ($\lambda_3 > 0$). Conversely, the square of GDP per capita expected to be below than 0 ($\lambda_4 < 0$) .This means there exists an inverted U-shape relationship. As GDP per capita increases, CO_2 emissions per capita will increase until the turning point and then CO_2 emissions per capita begin to decline.

CHAPTER IV
EMPIRICAL RESULT

4.1 Augmented Dickey and Fuller Test (ADF Test)

Prior to the test of cointegration, the Augmented Dickey and Fuller test is used to identify the order of integration of the variables. Because in the presence of I(2) or above, the computed statistics provided by Pesaran et al. (2001) become invalid. In ADF test, the null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis is based on MacKinnon (1996) critical values. The lag length is selected based on Schwarz information criterion (SIC), this ranges from lag zero to lag two.

Table 4.1 below summarizes the outcome of the ADF (Augmented Dickey and Fuller) unit root tests on the natural logarithms of the level and the first difference of the variables. As can be seen from this table, all series at their first difference from each country reject the null hypothesis that the series is autocorrelated and statistically significant, indicating that all the variables are integrated or stationary at their first difference I(1), and that none of the variables is I(2) or beyond. Our ARDL can be applied successfully in respect of the stationarity in this respect.

Table 4.1 Unit Root Test Results

Country		Variable	ADF test statistics	
			Intercept	Trend and intercept
Malaysia	Level	*co*	-0.58	-2.38
		e	-1.07	-2.07
		y	-1.59	-2.16
		y^2	-1.20	-2.21
		fd	-3.04*	-1.13
	First Difference	*co*	-7.66***	-7.56***
		e	-6.63***	-6.73***
		y	-5.42***	-5.51***
		y^2	-5.55***	-5.56***
		fd	-1.99***	-3.61**
Philippines	Level	*co*	-1.26	-1.53
		e	-2.36	-2.08
		y	-9.90	-1.79
		y^2	-2.11	-2.59
		fd	-2.12	-2.60
	First Difference	*co*	-5.56***	-5.47***
		e	-8.85***	-9.37***
		y	-3.44**	-3.41*
		y^2	-3.85***	-3.80**
		fd	-3.79***	-3.73**
Singapore	Level	*co*	1.10	0.03
		e	-1.85	-1.71
		y	-2.27	-2.09
		y^2	-1.72	-2.24
		fd	-2.92*	-2.58
	First Difference	*co*	-2.86**	-8.43***
		e	-7.19***	-7.29***
		y	-5.52***	-6.30***
		y^2	-5.81***	-6.28***
		fd	-5.68***	-5.96***
Thailand	Level	*co*	-0.70	-1.68
		e	0.12	-1.92
		y	-1.35	-1.72
		y^2	0.41	-1.99
		fd	-1.73	-2.08
	First Difference	*co*	-4.16***	-4.13**
		e	-4.54***	-4.48***
		y	-3.58***	-3.71**
		y^2	-4.57***	-4.52***
		fd	-3.09**	-3.30*

Note: ***, ** and * indicate the rejection of the null hypothesis of non-stationary at 1%, 5% and 10% significant level, respectively.

4.2 Bounding Test

Before the ARDL testing, optimal lag length of the variables should be selected relying on minimizing the Akaike Information Criterion (AIC). The maximum lag order 1 is set based on the annual frequency. With that maximum lag length order, the sample period is adjusted from 1971-2011 to 1972-2011. This setting also helps to save the degree of freedom, as available sample period is quite small. Thus, there are in total 40 observations for each country.

First, the F-statistics are analysed to justify the existence of the long-run relationship among variables in the system. Equation (3) is estimated by the OLS method. Then the Wald test is applied to calculate the F-statistic for joint significance of the variables. The null hypothesis is λ_1=λ_2=λ_3=λ_4=λ_5=0, against the alternative hypothesis of $\lambda_1 \neq 0, \lambda_2 \neq 0, \lambda_3 \neq 0, \lambda_4 \neq 0, \lambda_5 \neq 0$. The F-test is conducted to test the existence of the long-run relationship among the variables.

The F-test result with one lag orders is reported in Table 4.2. The computed F-statistics of Philippines and Thailand are below the criteria provided in Narayan (2005), indicating no evidence of long-run or cointegration relationship between variables. For Malaysia and Singapore, the computed F-statistics lie between the upper and lower bounds at 10% significance level, so it is inconclusive whether there are long-run or cointegration relationships among the considered variables. Therefore, the significance of the error correction term is examined in the next step for information on the existence of cointegration relationships (Iwata et al., 2012). Kremers et al. (1992) argue that conducting the test confirming whether the coefficient of an error correction term is significant or not is relatively more efficient approach in establishing cointegration. As shown in Table 4.2, the coefficients of ECM_{t-1} for Malaysia and Singapore are significantly negative and smaller than unity in absolute values. These results provide evidence supporting the evidence of a cointegration relationship among variables in these two countries.

Table 4.2 The Result of ARDL Cointegration

Country	AIC optimal lags	F-statistic at AIC-selected optimal lags	ECM_{t-1} (t-ratio)
Malaysia	(1,0,1,0,0)	2.8082	-0.49 (-2.9075)*
Philippines	(1,1,1,0,0)	1.795	-0.07(-0.59706)
Singapore	(1,0,0,0,0)	2.9131	-0.56(-4.2384)***
Thailand	(1,0,1,0,0)	1.318	-0.43(-2.8254)*
Critical values for F-statistic		Lower I(0)	Upper I(1)
	1%	4.045	5.898
	5%	2.962	4.338
	10%	2.483	3.708
Note: ***,**,* represent 1%, 5% and 10% level of significance, respectively. The critical value ranges of F-statistics with five explanatory variables are obtained from Narayan (2005)			

4.3 Long-run Relationship

Using Microfit 5, based on AIC, optimal lag is selected automatically. Table 4.3 presents the long-run estimation results along with diagnostic tests. Except for Singapore, the coefficients y and y^2 for the case of other countries are insignificant. Therefore, it is concluded that there is no EKC for Malaysia, Philippines and Thailand.

Table 4.3 Long-run Estimates Based on Selected ARDL Model

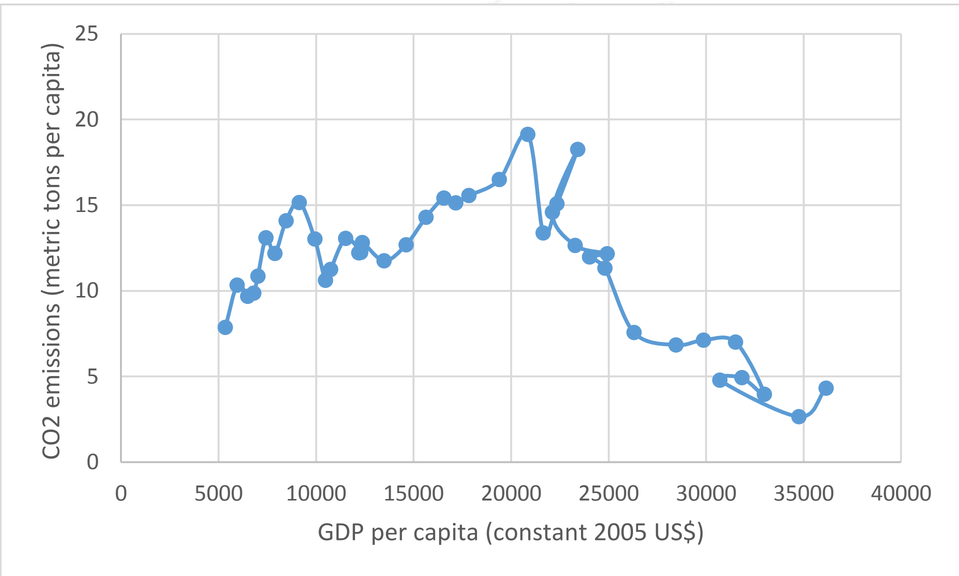
Variable	*e*	*y*	y^2	*fd*	*c*
Expected signs	+	+ / -	-	+/-	/
Malaysia	0.74(1.25)	-3.12(-0.62)	0.48(0.73)	0.04(0.28)	2.99(0.34)
Philippine	3.01(0.54)	0.57(0.28)	2.65(0.44)	-13.49(-0.44)	7.10(0.27)
Singapore	1.06(4.02)***	17.76(3.68)***	-2.28(-4.43)***	-0.10(-0.02)	-36.95(-3.91)***
Thailand	2.64 (1.37)	0.12(0.30)	-3.00(-0.92)	0.17(1.12)	-5.82(-1.88)*
Note: ***,**,* represent 1%, 5% and 10% level of significance, respectively.					

The significantly positive and negative signs of y and y^2 in the case of Singapore satisfy the EKC hypothesis for CO_2 emissions, indicating the EKC is valid in Singapore. This shows that an increase in per capita GDP initially contributes to growth of CO_2

emissions significantly, until it reaches its stabilization point, then decline. The effects of economic growth in Singapore is significant and dominant. A 1% of economic growth increases the CO_2 emissions by 17.76%, (-4.56) is the slope of the EKC curve, which is derived by dy^2/dc. To find the turning point, we can set 17.76-4.56y to 0. Therefore the turning point is around y=3.89. As y is taken the log form with base 10, the turning point will be GDP at USD 7,762.47 (Calculation: $10^{3.89}=7762.47$).

Figure 4.1 plots the relationship between CO_2 emissions and GDP per capita in Singapore between 1971 and 2011. It shows an upward trend of CO_2 emissions at early stages of income level and a clear downward trend after GDP per capital reach certain level. The long-run elasticity of CO_2 emissions, with respect to energy consumption, is 1.06%, indicating that for each 1% increase in per capita energy consumption, per capita CO_2 emissions rise by 1.06%. These findings of EKC are consistent with Lean and Smyth (2010) for ASEAN, Pao and Tsai (2011) for BRIC countries and Jalil and Feridun (2011) for China.

Figure 4.1 Plots of CO_2 emissions and GDP per capita in Singapore



Date Source: World Bank

In the long-run, the coefficients of GDP per capita and energy consumption with respect to CO_2 emissions in Malaysia, Philippines and Thailand are not statistically significant. Therefore, there is no evidence that economic growth and energy consumption can lead to higher level of CO_2 emissions in the long run in these 3 countries. However, in Singapore both GDP per capita and energy consumption are positive and statistically significant to CO_2 emissions. The results are in line with Ang (2007) , Ang (2008), Jalil and Mahmud (2009), Lean and Smyth (2010) and Pao and Tsai (2011).

Lastly, financial development seems has no effect on CO_2 emissions in all 4 countries, which differs from Jalil and Feridun (2011) in the case of China, Tamazian et al. (2009) for BRIC countries and Shahbaz et al. (2013) for Indonesia. That is, their studies find higher degree of financial development decrease the CO_2 emissions.

4.4 Short-run Dynamics

After testing long-run effects of energy consumption, economic growth, financial development on CO_2 emissions. The next step is to investigate the short-run dynamics.

The results are reported in Table 4.4. Although a positive and negative sign for y and y^2 are found in the cases of Thailand and Singapore, the results support the validity of EKC hypothesis in the short-run only in the case of Singapore as the related coefficient to y^2 is not significant in the case of Thailand. Therefore, EKC is found only in Singapore in the short-run, and its signs of the short-run coefficients are all same to the coefficients of the long-run but the magnitude are smaller. In other words, the long-run elasticities of each variables with respect to CO_2 emissions are higher than the short-run elasticities, which imply that the variables have a stronger impact in the long-run.

The short-run results also illustrate that economic growth is a major contributor to CO_2 emissions as expected and it is statistically significant in Philippines, Singapore and Thailand. The results are in line with Ang (2007), Jalil and Mahmud (2009), Tamazian et al. (2009), Lean and Smyth (2010) and Pao and Tsai (2011).

Table 4.4 Short-run Results Based on Selected ARDL Model

Regressor	Δe	Δy	Δy^2	Δfd	ecm(-1)
Expected signs	+	+/-	-	+/-	-
Malaysia	0.36(1.59)*	-0.66(-0.26)	0.23(0.67)	0.023(0.28)	-0.49(-2.91)*
Philippines	0.88(3.18)**	0.94(3.30)**	0.19(1.22)	-0.96(-1.23)	-0.07(-0.59)
Singapore	0.69(3.07)**	11.51(2.70)***	-1.47(-2.99)**	-0.01(-0.02)	-0.65(-4.23)***
Thailand	1.13(1.17)	0.74(2.89)*	-0.13(-0.83)	0.07(1.29)	-0.43(-2.82)*
Malaysia:	$ecm = co -0.75*e +3.13*y-0.49*y^2 -0.05*fd -2.99*c$				
Philippines:	$ecm = co-3.01*e-0.58*y-2.66*y^2 +13.50*fd-7.11*c$				
Singapore:	$ecm = co-1.06*e-17.77*y +2.28*y^2 +0.01*fd + 36.96*c$				
Thailand:	$ecm=co-2.64*e-0.13*y-0.18*fd +0.30*y^2 +5.82*c$				
Note: ***,** and * represent 1%, 5% and 10% level of significance, respectively.					

Regarding energy consumption with respect to CO_2 emissions, coefficients are positive and significant in Malaysia, Philippines and Singapore. This implies that energy consumption plays significant role in increasing CO_2 emissions in these countries in the short-run. The result are in line with Lean and Smyth (2010).

The coefficients for financial development with respect to CO_2 emissions are insignificant in all 4 country cases. This implies that there is no evidence supporting financial development has an effect on CO_2 emissions in the short- run.

Furthermore, the lagged error correction term, ECM_{t-1} is negative as expected in Malaysia, Singapore and Thailand, verifying the established cointegration relationship among the variables. The coefficient of ECM_{t-1} shows the speed of the adjustment back to the long-run equilibrium after short-run shock. The relatively high ECM_{t-1} coefficients imply a faster adjustment process. For example, in the case of Malaysia, the coefficient of ECM_{t-1} is (-0.49). This implies that nearly 49 percent of the disequilibria in real per capita CO_2 emissions of the previous year's shock can adjust back to the long-run equilibrium in the current year. In other words, the full convergence process takes around 2 years[5] to restore equilibrium when there is a shock to the steady-state relationship. The fastest speed of the adjustment back to the long-run equilibrium belongs to Singapore, followed by Malaysia and Thailand.

The results of diagnostic test such as normality of residual terms, Lagrange multiplier (LM) test for serial correlation, Autoregressive Conditional Heteroskedasticity (ARCH) test, White heteroskedasticity and specification showed that short-run model has successfully passed all diagnostic test.

4.5 Stability Test

Due to the structural changes in ASEAN, it is likely that the macroeconomic series may be subject to one or more structural breaks[6]. Therefore, the stability of short-run and long-run coefficients is checked through the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) proposed by (Brown et al. (1975)). The CUSUM and CUSUMSQ tests of structural stability provide evidence of the parameter stability of autoregressive models. It is important to conduct the stability test to ensure that there is no problem of recursive residuals in terms of mean (CUSUM test) and no recursive residuals (CUSUMSQ test) in terms of variance.

Figures 4.2-4.5 show the cumulative sum and cumulative sum of squares test. Two displayed straight lines in each graph represent the 5% level of significance. For all the countries, the plots of CUSUM and CUSUMSQ test statistics fall inside the critical bounds of 5% significance level. This implies that the estimated parameters are stable over the period.

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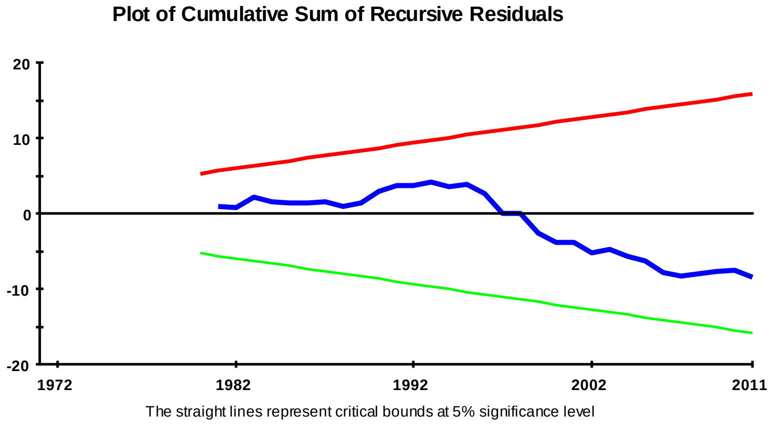
[5] As 49% of the disequilibrium adjust back to long-run equilibrium in a year after a shock, thus it will take 1/0.49 years restore equilibrium

[6] See more detail at Section 3.4

Figure 4.2 Plot of CUSUM and CUSUMSQ Tests for Malaysia



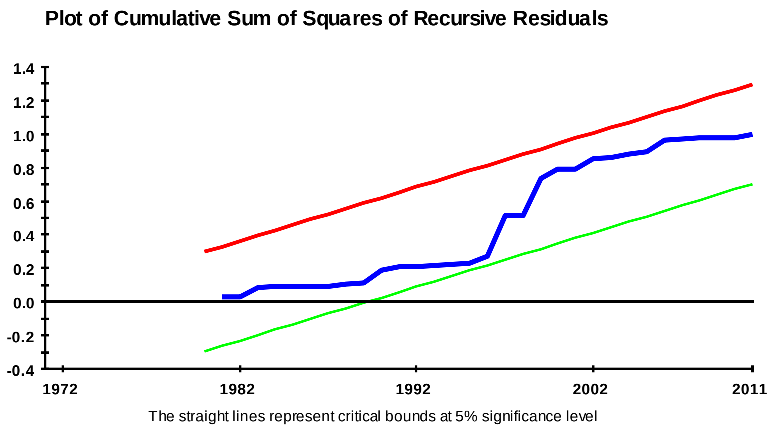
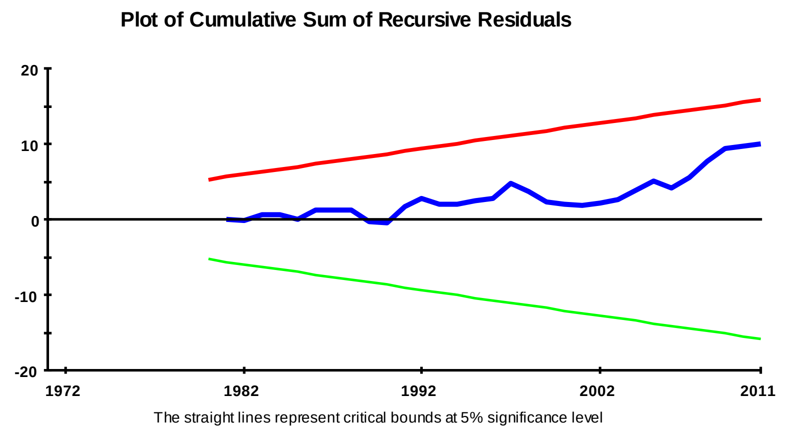


Figure 4. 3 Plot of CUSUM and CUSUMSQ Tests for Philippines



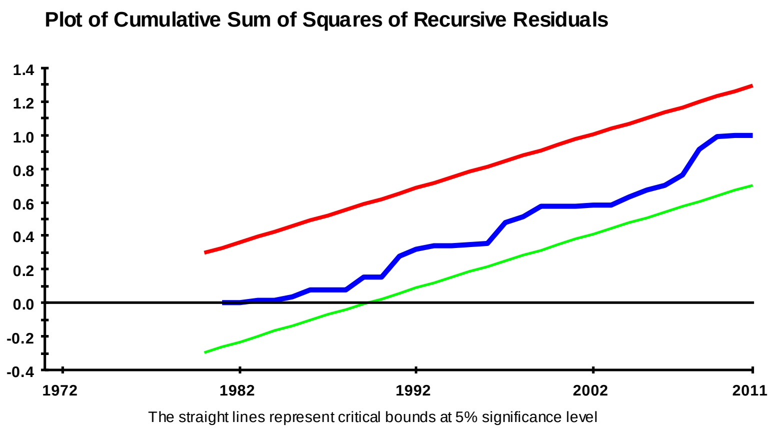
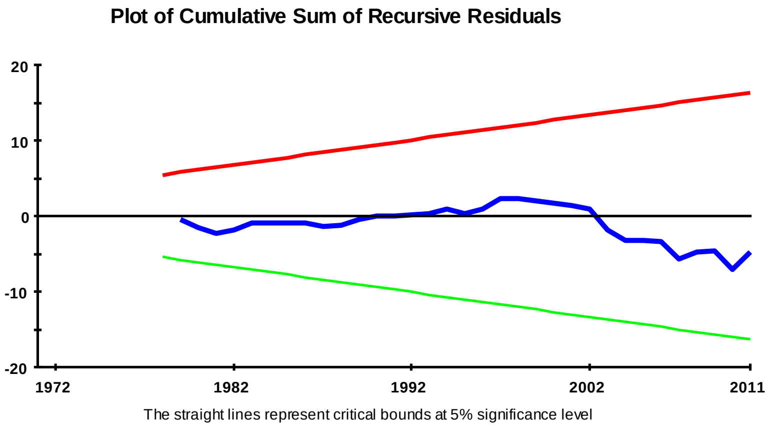


Figure 4. 4 Plot of CUSUM and CUSUMSQ Tests for Singapore



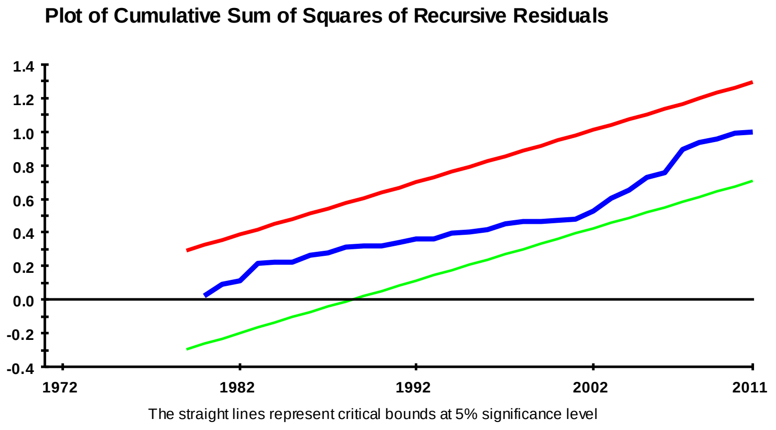
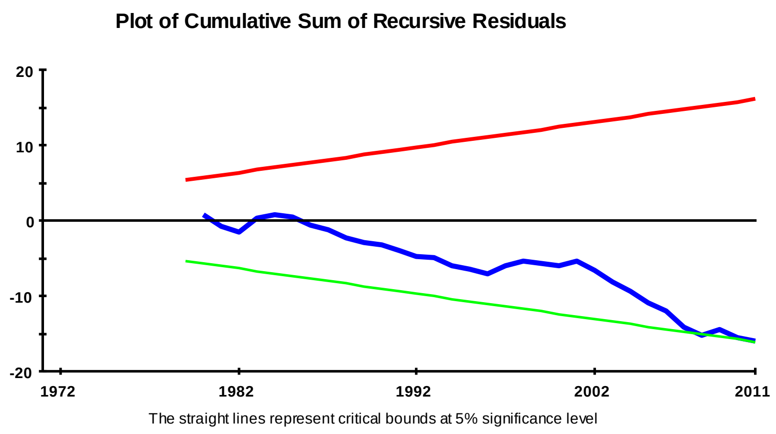
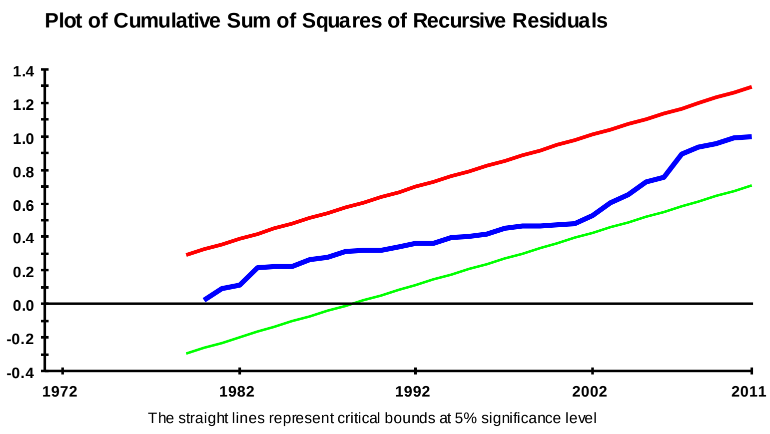


Figure 4. 5 Plot of CUSUM and CUSUMSQ Tests for Thailand





CHAPTER V
CONCLUSION

5.1 Conclusion

This study investigates the impacts of GDP growth, financial development and energy consumption on CO_2 emissions in 4 selected ASEAN countries, which are Malaysia, Philippines, Singapore and Thailand. The ARDL cointegration model is used and the period of study is from of 1971 to 2011.

Based on the results, only the case of Singapore can support the EKC hypothesis for CO_2 emissions in 4 ASEAN countries. The reason for the validity of EKC curve for Singapore may owe to its highest level of development among other selected countries. In other words, other countries may not yet reach the certain income level that growth will lead to improvement of environment conditions. Also, Singapore is considered as a developed country who has more access to clean technology.

In the long run, there is no evidence that economic growth and energy consumption can lead to higher level of CO_2 emissions in Malaysia, Philippines and Thailand, while in Singapore both GDP per capita and energy consumption are positive and statistically significant to CO_2 emissions.

In the short run, in Malaysia, only energy consumption per capita is significant and positive to CO_2 emissions, while in Thailand, only GDP per capita is positive. For Singapore and Philippines, both energy consumption and GDP per capita is positive, providing evidence that income and energy consumption are main factors in increasing CO_2 emissions in the short run.

ECM_{t-1} is negative as expected in Malaysia, Singapore and Thailand, verifying the established cointegration relationship among the variables. The coefficient of ECM_{t-1} shows the speed of the adjustment back to the long-run equilibrium after short-run shock. The fastest speed of the adjustment back to the long-run equilibrium belongs to

Singapore, followed by Malaysia and Thailand.

5.2 Policy implications

Empirical results in this study suggest a number of policy implications for the policy-makers. The findings obtained in this study fail to yield neither negative nor positive impact of financial development on CO_2 emissions. Hence, the roots of environmental policy can be found elsewhere.

Results of this study support the validity of EKC hypothesis in Singapore. Therefore, more R&D activities and energy efficient technologies should be encouraged to enhance domestic production. Government should encourage firms to adopt environmental-friendly technology and clean energy in production activities.

The short-run results illustrate that economic growth is a major contributor of CO_2 emissions in Philippines, Singapore and Thailand, policy-makers should take sustainable development plan into account when increasing per capita income.

In Malaysia, Philippines and Singapore, energy consumption is found to have a positive contribution to CO_2 emissions. Therefore, government of these countries may need to apply more energy conservative policies to help reducing CO_2 emissions. Another recommendation is to increase energy productivity by increasing energy efficiency, implementation of energy saving projects, and energy outsourcing to achieve its economic growth.

5.3 Limitation and Future Research

One of the limitations of this study is the limitation of data, which only covers annual data from 1971 to 2011.With longer span of years, it is possible to generate more accurate and stable results. Also, many data are not available for other ASEAN countries; therefore, only selected countries are in the research. Second, this study applies domestic credit to private sector as a proxy for financial development. Regarding to different status of financial development among ASEAN countries, future studies, which use other proxies for financial development, may provide further insight and more accurate results regarding the link between financial development and CO_2 emissions.

The present study can be augmented for future research by including other variable as potential determinants of CO_2 emissions such as trade, foreign direct investment (FDI) or interest rate.

APPENDICES

Appendices I Data of Malaysia

Country Name	Malaysia			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1971	1.491450516	541.2507407	1427.101963	22.5627171
1972	1.563103835	536.0952105	1523.124459	24.24050633
1973	1.491553162	520.140397	1660.714356	27.78935
1974	1.584082478	575.5939873	1756.223623	28.23650363
1975	1.579470868	593.1277861	1729.200277	34.31578005
1976	1.896414783	629.4462825	1885.085268	33.98255296
1977	1.753895583	621.7400866	1985.282573	35.82374768
1978	1.761545575	780.6629002	2069.195087	39.19284168
1979	2.01998951	893.4238113	2210.24815	41.47746855
1980	2.023859565	872.8753665	2318.253506	49.90939446
1981	2.173808169	907.8230305	2418.63054	57.76144273
1982	2.102079989	898.6549052	2498.27882	62.73292818
1983	2.543836407	1019.376798	2586.250046	69.92689228
1984	2.262852606	1025.422789	2713.126861	74.89013199
1985	2.298687671	1004.359269	2609.338829	88.17464825
1986	2.464895964	1094.852984	2564.984647	101.4660446
1987	2.440349148	1078.98626	2625.241551	89.57661713
1988	2.483672685	1099.606488	2802.487873	86.46248782
1989	2.817079161	1172.1147	2969.179005	95.65288455
1990	3.107600327	1217.04206	3147.108911	69.41266869

Country Name	Malaysia			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1991	3.666052373	1458.507999	3355.616532	73.76109175
1992	3.92082032	1566.724812	3559.617009	108.5299407
1993	4.65579306	1651.472364	3813.339741	106.4604252
1994	4.652623786	1603.731754	4060.494045	109.2177428
1995	5.844623648	1690.816822	4347.844791	124.4147129
1996	5.896967769	1822.481862	4662.2816	141.6342973
1997	5.723601318	2063.526965	4878.128023	158.3850476
1998	5.107167872	1913.346323	4407.957217	158.5048192
1999	4.713588472	1896.870718	4568.078725	149.1519893
2000	5.405598437	2113.459983	4861.889787	134.9998539
2001	5.715353558	2153.947356	4784.865156	129.1013756
2002	5.537623038	2183.873421	4943.412214	121.8276628
2003	6.444308539	2295.673768	5131.266687	118.9741489
2004	6.605572882	2422.338466	5379.281468	111.937369
2005	6.875947332	2580.514499	5564.173231	106.5244319
2006	6.497627846	2549.697849	5770.475031	103.6640041
2007	7.037791323	2742.500273	6026.652869	101.5800752
2008	7.656532739	2818.863511	6209.408389	96.74837916
2009	7.373235988	2637.675361	6012.923246	111.6069115
2010	7.986951475	2648.531482	6354.121216	107.1226222
2011	7.898823573	2717.399766	6584.312586	108.4259367

Appendices II Data of Philippines

Country Name	Philippines			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1971	0.748603832	415.8910512	846.0028163	19.98006212
1972	0.697230273	406.492298	866.812035	21.76156218
1973	0.808268019	439.9405249	917.5090602	22.94467361
1974	0.760435197	428.8176235	923.5583627	24.94745844
1975	0.787654399	442.1156064	947.9155439	24.99073645
1976	0.827340468	450.6354733	1003.071018	25.44119612
1977	0.842017425	456.7430219	1030.40663	26.54440327
1978	0.835298599	451.7759986	1054.330359	29.43575148
1979	0.827011463	465.5515402	1083.655163	31.20744209
1980	0.780641318	472.8996578	1108.608138	31.44115463
1981	0.711561732	462.5271925	1115.523906	32.84762568
1982	0.698999429	461.890994	1124.664835	33.41951024
1983	0.688288029	488.8371764	1114.873848	36.91167426
1984	0.586176501	427.8114004	1005.496115	24.47104852
1985	0.516329122	437.4133469	907.1564895	20.11495358
1986	0.523397955	425.7698586	913.2664778	14.85661543
1987	0.570273559	433.3576723	927.5628716	15.97594484
1988	0.641178568	446.4352355	964.424185	16.12294821
1989	0.648133813	457.4104114	998.035476	17.35945125
1990	0.674176857	463.4430954	1002.512529	19.26626174

Country Name	Philippines			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1991	0.69171314	451.389562	972.1914615	17.83868091
1992	0.749133194	460.5459763	951.9563091	20.64852515
1993	0.742367897	449.3201361	949.1173116	26.41413076
1994	0.80304133	470.308675	967.7461824	29.09331267
1995	0.869338185	481.4415083	989.8788713	37.53186729
1996	0.870174454	486.7337592	1024.254859	48.97984366
1997	0.9742004	500.9897717	1053.689399	56.45748231
1998	0.927455028	504.2586936	1024.969395	43.32174591
1999	0.906592594	506.5670187	1033.996425	38.51754017
2000	0.94065037	513.1386369	1056.791739	36.76903418
2001	0.892559534	481.0173706	1064.532155	37.52963629
2002	0.877524618	477.4572111	1080.4091	34.88447546
2003	0.862126962	469.0001055	1111.182215	33.14049065
2004	0.875524233	458.5236279	1162.837798	32.24141444
2005	0.868716929	451.044703	1196.539849	29.07347218
2006	0.772811732	440.3253967	1238.406098	28.69398668
2007	0.783104987	434.4023529	1299.976277	28.86413779
2008	0.841040935	444.1454968	1333.994338	29.0649782
2009	0.816054812	416.6938258	1329.51299	29.16279952
2010	0.878135471	434.1961817	1409.498047	29.5785341
2011	0.867845343	426.9552335	1438.473145	31.86832022

Appendices III Data of Singapore

Country Name	Singapore			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1971	7.853270387	1292.241469	5344.379414	44.90261475
1972	10.33281686	1569.470823	5955.947086	50.27959892
1973	9.676666211	1711.835841	6496.186729	59.12193056
1974	9.852451789	1795.979012	6802.207198	53.36318323
1975	10.84735746	1640.488376	7012.567531	56.00961538
1976	13.0974565	1693.247286	7433.215198	57.3460695
1977	12.17444631	1763.230121	7879.725721	58.18135114
1978	14.09090245	2214.630354	8462.520028	60.20475507
1979	15.15570254	2130.842459	9143.493504	64.60541257
1980	13.02164051	2125.96683	9933.409269	68.92365273
1981	10.60068027	2124.853376	10478.59438	75.3607714
1982	11.24154665	1987.087308	10747.97835	80.14766057
1983	13.05373059	2195.890358	11515.37694	85.65134296
1984	12.22547627	2455.484384	12294.19599	85.386792
1985	12.21414335	2472.968325	12193.05721	87.68882934
1986	12.81463745	2630.754383	12366.61615	84.4293012
1987	11.74850772	2757.880689	13492.44121	80.65930443
1988	12.68584397	2981.128615	14616.47173	76.45586036
1989	14.29189898	2896.500086	15638.96741	79.64961682
1990	15.40506516	3782.720276	16553.32167	79.14783292

Country Name	Singapore			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1991	15.12729041	4167.365585	17164.8176	79.85656293
1992	15.55924943	4588.433212	17837.37991	81.04488082
1993	16.48642737	5487.39494	19398.34678	80.91683293
1994	19.11875528	6460.26818	20853.25808	81.09456003
1995	13.36639773	5346.662199	21651.02482	88.21411628
1996	15.0667812	5358.274053	22354.49191	93.63691272
1997	18.24014775	5818.150925	23408.65459	96.43196939
1998	14.5887702	5083.249623	22123.27166	107.9571083
1999	12.64782052	4587.493492	23284.90384	102.7091301
2000	12.16662434	4634.72585	24921.28155	96.29355693
2001	11.97221516	5145.885754	24027.04395	115.6793506
2002	11.3102312	5065.984507	24811.51156	102.6862071
2003	7.566013727	6216.71293	26296.89507	105.4785385
2004	6.833825574	7370.394877	28449.62732	96.43899141
2005	7.116921432	5055.96632	29869.85398	89.4964022
2006	6.997632098	5264.398658	31514.57448	84.76219473
2007	3.965405127	4677.204306	32982.93973	85.80732594
2008	4.927577946	5094.135714	31832.68465	98.57004402
2009	4.778242444	4257.568962	30700.5915	97.73928206
2010	2.655230176	5006.620992	34758.13304	96.21759573
2011	4.320161437	5069.171794	36154.03726	106.2195416

Appendices IV Data of Thailand

Country Name	Thailand			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1971	0.506996471	360.5780862	631.6941232	20.56671375
1972	0.559033986	367.8643277	640.2207225	20.98228352
1973	0.60886946	388.5812535	686.3757128	22.52659241
1974	0.58765087	386.3534442	698.008951	24.20986731
1975	0.576534275	409.6024292	714.0903179	27.69157206
1976	0.66330279	434.1176356	761.7646884	34.49171658
1977	0.724054056	451.5105782	817.3604542	38.28634378
1978	0.772013732	458.7765058	881.5193686	41.70974909
1979	0.791514277	474.2972285	909.0818261	43.23802217
1980	0.846998833	464.3214751	936.480616	40.80779592
1981	0.787158397	460.0965672	972.2725835	41.95309762
1982	0.769491254	456.4678674	1005.002755	44.70609013
1983	0.845959176	411.6958205	1041.723373	53.0489719
1984	0.89957509	446.3907735	1081.765652	56.80305941
1985	0.935255919	475.3593231	1111.676804	58.34358603
1986	0.93773426	490.2662172	1151.91694	56.86201662
1987	1.054934555	531.7626952	1238.739959	59.50532154
1988	1.219717469	595.810237	1378.972557	64.10912583
1989	1.413508129	656.0570861	1522.704807	71.94095253
1990	1.693683193	741.2826726	1669.711306	83.36905192

Country Name	Thailand			
Indicator Name	CO2 emissions (metric tons per capita)	Energy use (kg of oil equivalent per capita)	GDP per capita (constant 2005 US$)	Domestic credit to private sector (% of GDP)
1991	1.838947637	795.9308406	1792.238093	89.09621705
1992	1.994194341	840.1411118	1919.149523	98.46947258
1993	2.244867961	879.2642158	2060.515641	108.0094734
1994	2.477231531	964.2512077	2206.910492	125.6789304
1995	2.827680548	1044.84627	2364.242666	138.7868121
1996	3.122393535	1156.355718	2472.312512	146.3120568
1997	3.189315169	1164.947847	2377.78905	166.5040754
1998	2.792862527	1079.690667	2170.958612	153.4056618
1999	2.949802786	1139.227982	2243.737106	127.7174345
2000	3.004394232	1152.999055	2316.818209	105.121739
2001	3.187444917	1173.03406	2369.334517	93.07844714
2002	3.367423073	1282.580235	2486.729718	96.86939149
2003	3.582350264	1374.806575	2637.520922	94.13466328
2004	3.858213428	1472.302695	2778.23044	95.14459027
2005	3.889368866	1503.180532	2874.386274	93.82990568
2006	3.992198458	1525.605035	3003.025752	88.90656207
2007	3.994687144	1585.965952	3157.697401	106.3624808
2008	3.984059667	1626.729752	3207.370338	105.7597313
2009	4.198511915	1618.395537	3179.148909	109.0358575
2010	4.470426149	1766.929356	3410.427649	115.7834838
2011	4.534491734	1759.276249	3428.017628	130.7239397

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