International Academic Institute for Science and Technology

International Academic Journal of Economics
Vol. 1, No. 2, 2014, pp. 62-79.

ISSN 2454-2474

International Academic Journal of Economics

www.iaiest.com

Economic Growth and Environment: The Case of Malaysia and Thailand

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Abstract

It is widely known that greenhouse gases contribute to a warmer climate. Therefore, it is essential to examine the effects of economic development on environment. In this study, a multivariate time series analysis of the factors that influencing CO_2 emissions in Malaysia and Thailand is conducted. It is expected that the determinants of CO_2 emissions, including economic growth, FDI, energy consumption, urbanization and trade openness will remain crucial in developing countries and understanding how these economic factors affects CO_2 emissions is essential to provide insight for policy implementation. The empirical results signify the existence of a long run relationship between all the independent variables with CO_2emissions in both countries, except for urbanization which only significant in the case of Thailand. On the other hand, urbanization is the only significant variable for CO2 emission in the model of Malaysia in the short run. Besides, the result revealed that both countries are still in the early stage of the EKC curve in which their economic growth increase as well as the CO_2 emission. With this in mind, both countries are still in the process of reaching the maximum turning point stated in the theory of EKC.

Keywords: Carbon dioxide; economic growth; Malaysia; Thailand

1. Introduction

Increasing concerns about the environmental problems have turned societies of both Malaysia and Thailand attention to examine the determinants of CO2 emissions and their influences. One of the key challenges faced by economists and policymakers is to achieve a long term sustainable development. Sustainable development involves achieving the goals of both economic development and environmental sustainability together. With this in mind, understanding and examining the determinants of CO2 emissions is crucial for the policymakers to make effective and efficient energy and environmental policy for their countries. In recent years, numerous studies have examined the connection between incomes and pollution by using the concept of the environmental Kuznets curve (EKC) (Shafik 1992; Seldon and Song 1994).

Some empirical studies stated that the literature of EKC hypothesis is econometrically weak with the assumptions of environmental degradation do not sufficiently affect the economic activity and the economy is sustainable (Stern et al. 1996). Some researchers argued that the GDP per capita alone does not have significant impact on CO_2 emissions, especially for less developed countries (Lin et al. 2016). A growing body of literature today has claimed that considering empirical evidence on the inflow of foreign direct investment (FDI), trade liberalization, energy consumption and urbanization, in particular, are important elements that should be included in the determinants of CO2 emissions (Zhang and Zhou 2016; Baek 2016).

Hence, this paper aims to investigate the causal relationship between FDI, income, energy consumption, trade liberalization, urbanization and environment in Malaysia and Thailand by applying econometric techniques. The results of this study are able to provide us a better insight about how FDI, income and energy consumption impact on environment quality of Malaysia and Thailand. Also, the policy makers are able to gain a clearer direction in designing efficient and effective policies to deal with the issues of global warming and environmental degradation in Malaysia and Thailand.

This paper is organised as follows: Section 2 presents the literature review on literature review on the relationship between economic growth and environment in developing countries; Section 3 describes the methodology adopted in this study; Section 4 presents the empirical results and Section 5 concludes the paper and discuss the policy implications.

2. Literature Review on the Relationship between Economic Growth and Environment in Developing Countries

The theoretical arguments and empirical evidence of the relationship between pollution emissions and FDI are inconclusive. The popular hypothesis test for the relationship between FDI and environmental degradation is the 'Pollution-Haven Hypothesis'. According to Rezza (2013) and Smarzynska and Wei (2001) support the pollution-haven hypothesis where they found the parent company of MNEs are receiving less investment in a more environmentally regulated host countries compared to those located in lax environmental regulations. However, the pollution haven hypothesis has been rejected by Al-mulali and Tang (2013), Tamazian et al. (2009) and Lee and Brahmasrene (2013) when they examine the validity of pollution-haven hypothesis in the Gulf Cooperation Council (GCC) countries, BRIC countries and European Union countries, respectively.

Besides, there is a group of researchers who investigated the relationships among energy consumption, economic growth and CO2 emissions in the literature (Ahmad et al 2016). These researchers were focused on examining the validity of EKC framework such as the quadratic relationship between CO2 emissions and economic growth. Managi and Jena (2008) found an EKC curve type relationship exist between economic growth and environmental productivity by using state-level industry data of various air pollutants such as nitrogen and sulphur dioxide in India; Al-Mulali et al. (2015) for Kenya; and Wang et al. (2016) for China. However, these single case studies also generated different results where Begum et al (2015) found that the EKC hypothesis is not valid in Malaysia while Ozturk and Al-Mulali (2015) for Cambodia and L´opez et al. (2015) for Venezuela did not find empirical evidence to validate the EKC hypothesis.

The relationship between trade liberalization and CO2 emissions has received great attention by researchers and policy makers in recent years. It has become increasingly important to examine the impacts of the potential determinants on the environment such as trade liberalization. Antweiler et al. (1998), Farhani et al. (2014) and Bento and Moutinho (2016) studied how trade liberalization to international goods market affects environment quality. They developed a theoretical model that divide the impact of trade liberalization on environment into scale, technique and composition effects and investigate this theory by using data on sulphur dioxide. The results reveal an interesting conclusion where trade liberalization appears to be good for the environment and raise the value of national output and income.

The rapid development of urbanization and industrialization can cause the consumption of energy to increase in a short period of time. Hossain (2011) used four different panel unit root tests to examine the causal relationships between CO2 emissions, energy use, economic growth, trade liberalization and urbanization for the Newly Industrialized Countries (NIC). The results show that there is no evidence of long-run relationship from the Granger causality test. However, he found that a higher energy use tends to contribute to higher CO2 emissions while the rests are normal good in the long -run. In contrast, Al-mulali et al. (2012) and Wang et al. (2016) found that there is existence of long-run cointegration relationship between urbanization and CO2 emissions.

Based on the previous studies, the findings are varied mainly due to the differences in countries under study and the methodology used.

3. Methodology

3.1 Theoretical Framework

3.1.1 Pollution Havens Hypothesis and Factor Endowment Hypothesis

Generally, FDI increases environmental degradation if only it is focusing on polluting industries. According to the pollution havens hypothesis (PHH), polluting industries or multinational firms tends to relocate to jurisdictions with lax environmental laws, also called as ‘pollution haven’, instead of relocating to more stringent locales. It suggests that countries with high environment monitoring will increase the costs of key inputs in their production of pollution-intensive goods, which loses their comparative advantage in competing with its competitors (Levinson). Thus, polluting industries will move away from stringent environmental regulations in developed countries in the form of FDI outflows and developing countries with less stringent environmental regulations will attract these FDI inflows from polluting industries.

On the other hand, another competing hypothesis that also used to estimate the effect of international trade on the environment is the factor endowment hypothesis (FEH). It posits that multinational firms move away from a country is based on the differences in endowments or technology rather than the differences in pollution policy. For instance, country with labor abundant tends to exports the labor-intensive pollution goods to enhances its production and achieve the economies of scales, but it also increases pollution in the labor abundant country. In contrast, country with scarce labor will reduce the pollution due to the limited number of labors can be used in the production of pollution-intensive goods **(Temurshoev 2006)**.

Therefore, the multinational firms that produce labor-intensive pollution goods will move to the labor abundant countries via the form of FDI outflows, to take advantage in its production. But this also increases the environmental degradation and pollution in the labor abundant countries, and vice versa. This question has been studied by **Temurshoev (2006)**; they examined the effects of international trade on the developed countries and developing countries by using two competing hypotheses which included the pollution havens hypothesis (PHH) and the factor endowment hypothesis (FEH). However, some studies included this economic variable in their studies such as **Pao and Tsai (2011)** and **Al-mulali (2012)**, they generated different result from the other studies that do not include FDI as one of the variables that determine or affect the CO_2 emissions in a country.

3.2Conceptual Framework

3.2.1 Trade liberalization and Environment

What is worrying to mainstream environmentalists and economists in recent is the extent of the criticisms of market liberalization policies. As the concerns about environmental degradation has become a global priority, the impact of international trade on the environment deserves further attention as it is growing importance in the policy of trade. Trade liberalization has globally affected the flow of trade in terms of exports and imports among the countries. According to the United State Energy Information Administration (EIA), the volume of CO_2 emissions for both developing countries and developed countries has been increased by 75 percent between 1980 and 2012 **(EIA 2013)**.

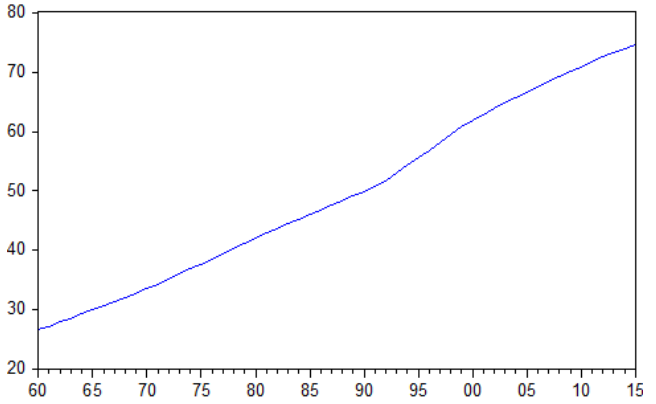
At the same time, the total volume of international trade also increased by 450 percent, as estimated by the World Development Indicators **(WorldBank 2015)**. Furthermore, EIA also estimated that the total amount of CO_2 emissions in developing countries have been grown in a rapid pace in the recent years and thus, the CO_2 emissions in developing countries are predicted to be 127 percent higher than in developed countries by 2040 **(EIA 2013)**. Some researchers claimed that it may occur due to the free trade policies where developed countries reduce their production of pollution-intensive good with the advantages of globalization **(Shahbaz et al 2013)**. Thus, important discussions are carried out on the effects of international trade on the environment impacts of CO_2 emissions.

According to the chief economist of the World Bank, Lawrence Summer, he debates that the World Bank should encourage more migration of the pollution firms to the developing countries **(Summers 1991)**. In this line, developing countries are agreed to increase their prosperity and life standards through the pollution firms and environmental degradation **(Ertugrul et al. 2016)**. As a result, an increase in the volume of international trade and migration of pollution firms to the less developed countries brings along environmental issues.

3.2.2 Urbanization and Environment

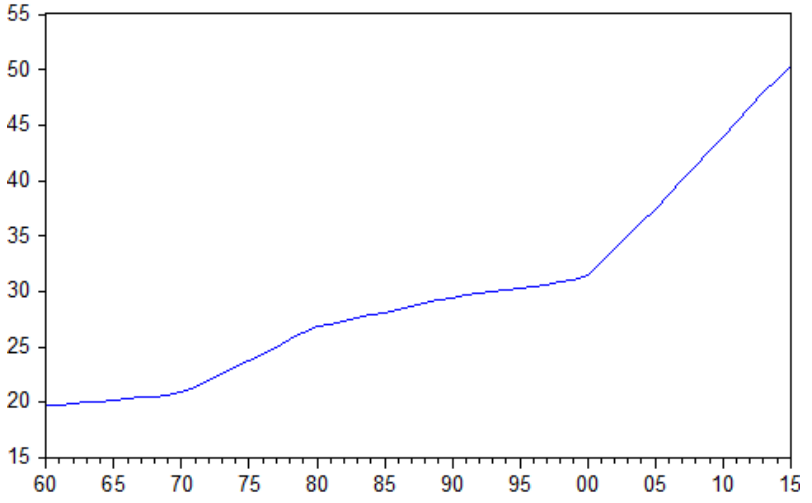
The way of living of urban population is differ from that rural population. Urban population is more likely to change their environment through their consumption behaviour which in turn pollute the environment and affect the health and quality of life. In addition, urban population consumes a huge amount of durable goods and energy mainly for food, transportation and electricity which may potentially harm the environmental quality. The major reason is that there are larger percentage of populations are living in the urban areas than the rural areas and the urban areas are more developed. According to the data from World Bank, there are 75 percent and 50 percent of the total population in Malaysia and Thailand are living in the urban areas for 2015, respectively **(refer to Figure 3.1 and 3.2)**.

Figure 3.1: Urban population (% of total) in Malaysia from 1960 to 2015.



Source: World Bank 2016

Figure 3.2: Urban population (% of total) in Thailand from 1960 to 2015.



Source: World Bank 2016

According to the US Environmental Protection Agency (EPA), the Urban Heat Islands (UHI) is one of the factors that can lead to environmental degradation due to development and changes in the temperature **(EPA 2016)**. In this line, the increasing demand for energy can cause UHI that can change local weather conditions and hence, lead to global warming. For instance, the temperature of Kuala Lumpur in Malaysia or Bangkok in Thailand is usually warmer than the surrounding countryside. Also, the usage of vehicle for transportation deserve better attention as it affect the air quality by increasing GHG emissions, especially in the urban areas. However, the impact of urbanization on the environment is not necessarily linear as small areas also can cause large issues. In this case, there is a need to determine the extent of the environmental impacts in the country as a whole but not determine by the size of a certain areas (Torrey 2004).

With this in mind, many environmentalist and researchers realized that the urbanization plays a huge role in the release of GHG as the country become more urbanized along with the rapid development of a country's economy. According to Dr. Pongsak Semson, the secretary for Bangkok Metropolitan Administration (BMA), urbanization could significantly affect global CO_2 emissions in the future because the process of urbanization and industrialization will contribute to the acceleration of global warming (BMA 2009). In order to find out how urbanization might impact environment through climate change or global warming, some researchers like Al-mulali et al. (2012) developed scenarios for urbanization, energy use and CO_2 emission. Since there are few study examine the impact of urbanization on environment, this study includes additional variable of urbanization to test whether this economic variable is significant enough in affecting the CO_2 emissions in Malaysia and Thailand.

3.3 Method

In this study, the unit root test will be conducted for the examination of stationarity of the variables. The integration properties of the variables are examined by using the Augmented Dickey Fuller (ADF) test. Thereafter, the cointegration test is employed if the variables are in the same order of I(1). Also, the Vector Error-Correction (VEC) model will be used to examine their Granger causality. Lastly, there are several diagnostic tests employed to examine the appropriateness of the model.

The main objective of this study is to examine the dynamic relationship between FDI, income, energy consumption, trade liberalization, urbanization and environment in Malaysia and Thailand. Based on the previous literature, there are three main economic variables that are widely used as major determinants of CO2 emissions, namely GDP per capita, FDI net inflows, and total energy consumption. However, this study includes trade openness and urbanization into the model to test whether the trade liberalization and urbanization are also significant in affecting the environmental quality of Malaysia and Thailand. Thus, the dependent variable for this study is CO2 emissions per unit of output while GDP per capita (GDPP), energy consumption (ENE), trade openness (OPE), Foreign Direct Investment (FDI) intensity (FDII), and urban population (URB) as independent variables. Since it is widely assumed that CO2 emission is discharged by economic activities, therefore the model that applies in this study is specified as follows:

$$CO2O_t = \alpha_t + \beta_1 ENEP_t + \beta_2 FDII_t + \beta_3 GDP_t + \beta_3 OPE_t + \beta_4 URBP_t + \varepsilon_t \qquad (1)$$

where

$CO2O_t$ = Carbon Dioxide (CO2) Emissions (per unit of output)

$ENEP_t$ = Energy Consumption of Fossil Fuel (kg of oil equivalent per capita)

$FDII_t$ = Foreign Direct Investment (FDI) intensity (% of GDP)
GDP_t = Gross Domestic Product (GDP) (current US$)
OPE_t = Trade (Export +Import / GDP) (% of GDP)
$URBP_t$ = Urban Population
ε_t = Residual

Furthermore, the equation (1) will be transformed into log-linear form due to the different characteristic of the dataset. Thus, the equation (2) will be adopted in this study as below:

$$LCO2O_t = \alpha_t + \beta_1 ENEP_t + \beta_2 FDII_t + \beta_3 LGDP_t + \beta_3 OPE_t + \beta_4 URBP_t + \varepsilon_t \quad (2)$$

The annual time series data of interested variables from 1977 to 2013 for Malaysia and Thailand are employed and extracted from the world development indicator (WDI) dataset and Passport (Gmid) dataset.

4. Empirical Result and Discussion

4.1 Unit Root Test

Table 4.1: Unit Root Tests Result

Augmented Dickey-Fuller Test for Malaysia				
Variable	Level		First different	
	Intercept	Trend & intercept	Intercept	Trend & intercept
LCO2O	0.8318(0)	0.504(0)	0.0004(1)***	0.0023(1)***
ENEP	0.5014(1)	0.7226(1)	0.0074(2)***	0.0150(2)**
FDII	0.1742(0)	0.4201(1)	0.0010(1)***	0.0001(1)***
LGDP	0.8085(0)	0.2583(0)	0.0002(0)***	0.0015(0)***
OPE	0.4258(1)	0.9980(0)	0.0050(0)***	0.0647(2)*
URBP	0.9830(0)	0.9080(0)	0.0004(0)***	0.0011(0)***
Augmented Dickey-Fuller Test for Thailand				
Variable	Level		First different	
	Intercept	Trend & intercept	Intercept	Trend & intercept
LCO2O	0.1510(0)	0.1023(0)	0.0011(0)***	0.0056(0)***
ENEP	0.3949(0)	0.9656(0)	0.0008(1)***	0.0010(1)***
FDII	0.2872(1)	0.1279(2)	0.0001(1)***	0.0009(1)***
LGDP	0.8176(1)	0.4280(1)	0.0060(0)***	0.0302(0)**
OPE	0.8276(0)	0.2190(0)	0.0126(2)**	0.0004(1)***
URBP	0.1476(1)	0.3260(1)	0.0042(0)***	0.0174(0)**

Note: Figures in ( ) are the lag lengths. Asterisks (*), (**) and (***) denote significant at 10%, 5% and 1% levels,
respectively.

In Table 4.1, the dependent variable and independent variables, namely LCO2O, LENE, FDII, OPE, LGDPP and LURB are all insignificant at level for both countries, meaning that the series are nonstationary and there is unit root present in the data at level. Hence, the alternative hypothesis of stationary or the series does not contain a unit root was rejected. However, all of the variables are significant at first difference with both intercept and trend and intercept. In overall, the results show that all of the variables of Malaysia and Thailand are mostly significant at 1% significance level with intercept, while only some of the variables are significant at 5% and 10% significance level with trend and intercept. As a result, the null hypothesis of nonstationary or the series contains a unit root was rejected after first differencing.

4.2 Cointegration Test Result

Table 4.2: Johansen and Juselius Cointegration Tests Results for Malaysia

Trace Test: LCO2O, LENE, FDII, OPE LGDPP, LURB (k = 1, r = 1)			
Null, H_0	**Alternative, H_1**	**λ-trace**	**95% CV**
r = 0	r ≥ 1	120.983**	95.754
r ≤ 1	r ≥ 2	62.267	69.819
r ≤ 2	r ≥ 3	34.893	47.856
r ≤ 3	r ≥ 4	18.540	29.797
r ≤ 4	r ≥ 5	5.922	15.495
r ≤ 5	r ≥ 6	1.032	3.841
Maximum Eigenvalue Test: LCO2O, LENE, FDII, OPE, LGDPP, LURB (k = 1, r = 1)			
Null, H_0	**Alternative, H_1**	**λ-max**	**95% CV**
r = 0	r ≥ 1	58.715**	40.078
r ≤ 1	r ≥ 2	27.374	33.877
r ≤ 2	r ≥ 3	16.354	27.584
r ≤ 3	r ≥ 4	12.618	21.132
r ≤ 4	r ≥ 5	4.889	14.265
r ≤ 5	r ≥ 6	1.032	3.841

Note: k is the number of lag and r is the cointegrating vector. Asterisks (**) indicate significant at 5% level.

Table 4.3: Johansen and Juselius Cointegration Tests Results for Thailand

Trace Test: LCO2O, LENE, FDII, OPE LGDPP, LURB (k = 1, r = 1)			
Null, H_0	**Alternative, H_1**	**λ-trace**	**95% CV**
r = 0	r ≥ 1	128.775**	95.754
r ≤ 1	r ≥ 2	67.810	69.819
r ≤ 2	r ≥ 3	36.261	47.856
r ≤ 3	r ≥ 4	16.440	29.797
r ≤ 4	r ≥ 5	4.290	15.495
r ≤ 5	r ≥ 6	0.632	3.841

Maximum Eigenvalue Test: LCO2O, LENE, FDII, OPE, LGDPP, LURB (k = 1, r = 1)			
Null, H_0	**Alternative, H_1**	**λ-max**	**95% CV**
r = 0	r ≥ 1	60.965**	40.078
r ≤ 1	r ≥ 2	31.549	33.877
r ≤ 2	r ≥ 3	19.822	27.584
r ≤ 3	r ≥ 4	12.149	21.132
r ≤ 4	r ≥ 5	3.659	14.265
r ≤ 5	r ≥ 6	0.632	3.841

Note: k is the number of lag and r is the cointegrating vector. Asterisks (**) indicate significan at 5% level.

In Table 4.2, it shows the trace test and maximum eigenvalue test results for Malaysia. In this line, the trace test output of 120.983 is greater than 95% of critical value of 95.754, while the maximum eigenvalue output of 58.715 also greater than 95% of critical value of 40.078. Thus, the results from these tests indicate that there is one cointegration vector and significant at 5% level of significance level. On the other hand, the Table 4.3 shows the trace test and maximum eigenvalue test results for Thailand. Likewise, the trace test output of 128.775 is greater than 95% of critical value of 95.754, while the maximum eigenvalue output of 60.965 also greater than 95% of critical value of 40.078. Hence, the results from these tests infer that there is also one cointegration vector and significant at 5% level of significance level.

Table 4.4: Vector Error Correction Model

Normalized Cointegration Vector in Malaysia	
CointegrationEq:	Normalized [t-statistics]
Constant	14.626
ENEP	-22.504 [-8.356]***
FDII	1.902 [3.188] ***
LGDP	0.437 [5.356]***
OPE	1.165 [8.613]***
URBP	2.690 [0.895]
Normalized Cointegration Vector in Thailand	
CointegrationEq:	Normalized [t-statistics]
Constant	-12.700
ENEP	4.260 [9.102]***
FDII	19.155 [4.500] ***
LGDP	0.779 [4.760]***
OPE	-4.923 [-8.256]***
URBP	32.994 [7.056]***

Notes: The estimated coefficients were obtained by normalizing the independent variables with respect to their respective dependent variable (LCO2O). Asterirks (***) indicate statistically significant at 1% level.

4.2.1 Effect of Energy Consumption

Based on the results in Table 4.4, it shows that there is negative and significant relationship between CO_2 emissions (LCO2O) and energy consumption (ENEP) in Malaysia. Specifically, the t-statistic value for energy consumption in Malaysia is 8.356, and it is greater than the t-critical value of 1%, which indicates that the variable is significant at 1%. It suggests that CO_2 emissions decrease as energy consumption increases. This result is consistent with Shahzad et al. (2017). According to Shahzad et al. (2017),energy consumption could generate negative effect on CO_2 emissions when the level of energy consumption reaches a certain maximum point and this may be due to the technology effect and government policies that urges the MNCs and industrial sectors to reduce the CO_2 emissions by increasing energy efficiency.

On the other hand, the t-statistic value for energy consumption in Thailand is 9.102, and it is greater than the t-critical value of 1%. The result infers that energy consumption has a strong and positive impact on CO2 emissions in Thailand. This is mainly due to the intensive energy consumption in the power, industrial and transport sectors, which generated a huge proportion of CO2 emissions, especially during the process of industrialization in both countries. Also, this relationship is consistent with other empirical studies, including Begum et al (2015), Ozturk and Acaravci (2010) and Ang (2008).

4.2.2 Effect of FDI on CO_2 Emissions

Based on the result from Table 4.4, FDI has a positive and significant long run relationship with CO_2 emissions in Malaysia and Thailand. Specifically, the t-statistic value for FDI in Malaysia is 3.188, and it is greater than the t-critical value of 1%. This suggesting that CO2 emissions increase as FDI increases. Similarly, the t-statistic value for FDI in Thailand is 4.5, and it is greater than the t-critical value of 1%, which indicates that the variable is significant at 1% significance level. Both results in line with the theoretical expectation of Pollution–Haven Hypothesis.

4.2.3 Effect of GDP and Trade on CO_s Emissions

For Malaysia, the sign of GDP and OPE is positive and significant based on the result from Table 4.4. The t-statistic value for GDP and OPE in Malaysia is 5.356 and 8.613,respectively. Also, these two variables are greater than the t-critical value of 1%, meaning that they are significant at 1% significance level. This implies that the impact of economic growth and trade openness on CO_2 emissions is positive and significant. This result is consistent with Baek et al. (2008). According to Baek et al. (2008), trade openness and economic growth tend to have detrimental effects on environmental quality in most developing countries such as Malaysia.

Similarly, GDP has a positive and significant long run relationship with CO_2 emissions in Thailand. The t-statistic value for GDP in Thailand is 4.760, and it is greater than the t-critical value of 1%, which indicates that the variable is significant at 1% significance level. However, the result shows that the sign of OPE is negative and significant in Thailand. The results suggest that trade openness improves environment quality by reducing CO_2 emissions.

One reasonable interpretation for the effect of trade and GDP on environmental quality in Malaysia is that increase in trade could generate income gains, which implies that trade is in fact beneficial primarily because of its effect on wealth to the country. In this line, this could link to the emissions intensity that is generally known as the ratio of a measure of environmental quality to a measure of GDP. However,

deterioration of emissions intensity could lead to the conclusion that there is a positive relationship between economic growth and CO_2 emissions. This can be explained to indicate that the economy has not reached the turning point stated in the EKC hypothesis. Also, this phenomenon can be applied in the presence of positive and significant long run relationship between economic growth and CO_2 emissions in Thailand.

On the other hand, the result shows that the OPE is having negative and significant long run relationship with CO_2 emissions in Thailand which is consistent with the findings of Shahbaz et al. (2013) and Le et al. (2016). According to Shahbaz et al. (2013) and Le et al. (2016), this negative long run relationship between trade openness and CO_2 emissions is mainly due to three different types of effects, namely scale, technique and composition effect.

4.2.4 Effect of Urbanization on CO_2 Emissions

The results in Table 4.4 show that the sign of URBP is positive but not significant in Malaysia. Specifically, the result indicates that the urbanization does not statistically significant impact on the emission of energy pollutant, meaning that urbanization is not strong enough in influencing the emissions of CO2 in Malaysia. Nevertheless, this result is consistent with Behera and Dash (2017). Besides that, the t-statistic value for URBP in Thailand is 7.056, and it is greater than the t-critical value of 1%, which indicates that the variable is significant at 1% significance level. As a result, the URBP has relatively strong impact on the CO2 emissions in Thailand than Malaysia. Also, the coefficient value of urbanization in Thailand is the largest among the other variables in terms of positive relationship. Thus, the results are consistent with Zarzoso and Maruotti (2011) and Li et al. (2015). With the development of urbanization of urban population, there is a huge strand of literature claimed that urban population is the major determinant of energy consumption (Li et al. 2015). In other word, urbanization involves industrialization and lead to dense population. This phenomenon could increase the resource usage and consumption of goods and services such as televisions and refrigerator, which could in turn increase the emission of CO2.

4.3 Wald Test and VEC Granger Causality Wald Test Results

4.3.1 Malaysia

Table 4.5: Wald Test results for Malaysia

	F-statistics (*p*-value)
Wald Tests	**LCO2O**
LCO2O	0.860(0.438)
ENEP	0.254(0.778)
FDII	0.262(0.772)
LGDP	0.787(0.469)
OPE	0.134 (0.875)
URBP	2.816(0.084)*

Table 4.6 VEC Granger Causality Wald Test results for Malaysia

Dependent Variable	ΔLCO2O	ΔLENEP	ΔLFDIC	ΔLOPE	ΔLGDPP	ΔLURBP	ECT	
	χ^2-statistics (*p*-value)						Coefficient	*t*-statistics
ΔLCO2O	-	0.509 (0.776)	0.524 (0.770)	1.573 (0.455)	0.268 (0.874)	5.633 (0.060)*	-0.346	-1.676*
ΔENEP	2.504 (0.286)	-	3.423 (0.181)	3.108 (0.211)	1.141 (0.565)	1.069 (0.586)	-0.024	-1.435
ΔFDII	1.210 (0.546)	5.320 (0.070)*	-	0.938 (0.626)	4.234 (0.120)	3.679 (0.159)	0.057	1.378
ΔLGDP	3.650 (0.161)	1.821 (0.402)	0.534 (0.766)	-	0.644 (0.725)	0.559 (0.756)	0.041	0.127
ΔOPE	7.670 (0.022)**	1.030 (0.597)	0.940 (0.625)	1.183 (0.554)	-	2.901 (0.235)	0.575	2.656***
ΔURBP	0.089 (0.957)	0.622 (0.733)	2.103 (0.349)	0.240 (0.887)	1.354 (0.508)	-	0.009	1.641

Notes: The χ^2-statistics tests the joint significance of the lagged values of the independent variables, and t-statistic indicates the significance of the error correction term(s). Δ is the first different operator. Figures in parentheses are the p-values. Asterisks (*) and (**) indicate statistically significant at 10% and 5% levels, respectively.

In Table 4.5, the variables namely LCO2O, ENEP, FDII, LGDP and OPE are not significant in Malaysia. All of the variables are having a p-value that less than 10% significance level, except for the p-value of URBP that greater than 10% significance level. As a result, there is only URBP having short run impact in the model of Malaysia. Also, this is consistent with the low error corrected term (ECT) value of -0.346, indicating that the deviation from the long run equilibrium will be corrected with 34.6% within a year. It indicates that the process of reaching full convergence will take more than a year in order to reach the stable path of equilibrium. This implies that adjustment process is slow and significant for Malaysian economy in any shock to carbon emissions equation.

Besides, the results in Table 4.6 show that there are causality relationships among the independent variables in Malaysia. Based on the results from Table 4.6, there is significant granger causality relationship from URBP to LCO2O. This indicates that urbanization is significantly granger causing CO2 emissions at 10% significance level. In addition, there is a significant relationship from ENEP to FDII, which leads to the conclusion that energy consumption is significantly granger causing FDI at 10% significance level. Since majority of the MNCs are using energy from coal and fossil fuel, the energy consumption has the highest FDI coefficient. Besides, the causal relationship flow from LCO2O to OPE is significant, meaning that it is significantly granger causing FDI at 5% significance level.

4.4.2 Thailand

Table 4.7: Wald Test results for Thailand

Wald Tests	**F-statistics (p-value)** **LCO2O**
LCO2O	0.276(0.762)
ENEP	0.179(0.837)
FDII	1.781(0.194)
LGDP	0.845(0.444)
OPE	0.994(0.388)
URBP	1.693(0.209)

Table 4.8 VEC Granger Causality Wald Test results for Thailand

Dependent	ΔLCO2O	ΔLENEP	ΔLFDIC	ΔLOPE	ΔLGDPP	ΔLURBP	ECT	
Variable	χ^2-statistics (*p*-value)						Coefficient	*t*-statistics
ΔLCO2O	-	0.358 (0.836)	3.561 (0.169)	1.691 (0.429)	1.988 (0.370)	3.387 (0.184)	-0.147	-1.776*
ΔENEP	0.515 (0.773)	-	0.180 (0.914)	0.194 (0.907)	0.122 0.941	2.065 (0.356)	-0.012	-0.276
ΔFDII	5.799 (0.055)*	3.969 (0.137)	-	36.935 (0.000)***	3.771 (0.152)	11.436 (0.003)***	-0.023	-1.533
ΔLGDP	5.611 (0.061)*	0.371 (0.831)	0.791 (0.673)	-	2.858 (0.240)	0.003 (0.999)	-0.215	-1.234
ΔOPE	0.405 (0.817)	1.937 (0.380)	7.448 (0.024)**	0.092 (0.955)	-	0.892 (0.640)	-0.272	-2.465***
ΔURBP	5.369 (0.068)*	0.649 (0.723)	0.775 (0.679)	13.435 (0.001)***	1.118 (0.572)	-	0.011	1.699*

Notes: The χ^2-statistics tests the joint significance of the lagged values of the independent variables, and t-statistic indicates the significance of the error correction term(s). Δ is the first different operator. Figures in parentheses are the p-values. Asterisks (*) and (**) indicate statistically significant at 10% and 5% levels, respectively.

For Thailand, all of the variables are not significant as none of the p-value is less than the critical value of 10% significance level based on the result in Table 4.7. As a result, there is no any short run relationship exist in the model of Thailand. In addition, this is consistent with the low error corrected term (ECT) value of -0.147, meaning that the deviation from the long run equilibrium will be corrected with approximately 14.7% within a year. Hence, the variables require longer period of time for converging into equilibrium. It suggests that the adjustment for any shock to CO2 is relatively slow for Thai economy.
On the other hand, there are causality relationships among the independent variables in Thailand as show in Table 4.8. There is significant granger causality relationship flow from LCO2O, LGDP and URBP to FDII. This indicates that majority of the FDI coefficient can be explained by the CO2 emissions, economic growth and the growth in urban population. For instance, the level of CO2 emissions, economic activity and urbanization could influence the level of FDI; a high level of CO2 emissions, economic activity and urbanization leads to a high level of energy consumption. Besides, there is also causal relationship flow from LCO2O to LGDP, from FDII to OPE and from LCO2O and LGDP to URBP.

4.5 Diagnostic Tests Results

Table 4.9: Diagnostic Test Results

Malaysia	
Diagnostic Tests	**F-statistic (*p*-value)**
JB	0.215 (0.898)
AR[2]	0.835 (0.236)
ARCH[1]	0.546 (0.450)
RESET[1]	0.332 (0.572)
CUSUM	Stable
$CUSUM^2$	Stable
Thailand	
Diagnostic Tests	**F-statistic (*p*-value)**
JB	0.211 (0.900)
AR[2]	1.289 (0.119)
ARCH[1]	0.222 (0.628)
RESET[1]	0.534 (0.474)
CUSUM	Stable
$CUSUM^2$	Stable

Note: AR[2] and ARCH[1] are Lagrange Multiplier tests of 2nd order serial correlation and 1st order ARCH
effects. RESET[1] refer to 1st order Ramsey RESET specification test. CUSUM is cumulative sum of recursive
residual stability test.

The models of both countries are also subjected to the CUSUM and CUSUM of square tests for parameter instability. The results of the diagnostic tests for Malaysia and Thailand are show in Table 4.9 and none

of the diagnostic tests for the models are significant. It leads to the conclusion that the null hypothesis of the model does not contain model specification error cannot be rejected. As a result, the models are not serially correlated and well designated. Also, both models are free from heteroscedasticity error and correctly fitted. Furthermore, the stable results of CUSUM and CUSUM of square test infers that the models do not suffer from parameter instability in both countries.

5. Conclusion and Policy Implication

The empirical results revealed several interesting findings as accordance to the objectives stated in this study. First, there is an existence of a long run cointegrating relationship among the variables of interest in Malaysia and Thailand. However, the evidence of a significant long run relationship between urbanization and CO_2 emissions was not found in Malaysia. In the short run, only urbanization was found to be significant in influencing the CO_2 emissions in Malaysia. Second, the results revealed that both countries are still in the early stage of the EKC curve in which economic growth increase as well as the CO_2 emission. With this in mind, both countries are still in the process of reaching the maximum turning point stated in the theory of EKC. Third, the effect of urbanization and trade openness is strong enough in influencing the CO_2 emissions in Thailand instead of Malaysia in the long run. Nevertheless, these variables should be considered as important determinants of CO_2 emissions, except urbanization as this variable was found to be insignificant for Malaysia in the long run.

In overall, the results are consistent with the finds of various researchers in the same field of study. This study suggests that urbanization and trade openness have different effects on CO_2 emissions in different countries due to the different use of government policies. Based on the findings, the policy makers of Malaysia should review their trade policy to reduce the CO_2 emission. Besides, the consumption of energy and the ratio of FDI flows into Malaysia and Thailand could significantly influence the CO_2 emissions. As such, both Malaysia and Thailand should continue to raise the share of renewable energy by implementing policies that encourage the local producers and MNC to use renewable energy and the policy makers need to embrace more energy conservation policies to lower the emission and environmental degradation in order to enhance energy efficiency of those recipient countries. More importantly, both Malaysia and Thailand should focus on sustainable development and promote economic activities that is conducive in reducing the CO_2 emission in order to reach the maximum turning point stated in the EKC theory; an increase in the economic growth will reduce the CO_2 emission.

In addition, Malaysia and Thailand should come to a stringent environmental regulating policies as well as a cross-country agreement with other middle income countries so that the environmental degradation and CO_2 emissions can be checked to a certain threshold level.

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