https://doi.org/10.52131/jee.2020.0101.0003

*i*RASD Journal of Energy & Environment

Volume 1, Number 1, 2020, Pages 26 - 37

Journal Homepage:
https://journals.internationalrasd.org/index.php/jee

Analyzing the long run linkage between Population, Economic Development and Energy Consumption on Carbon emissions of ASEAN Nations

Tusawar Iftikhar Ahmad[1], Mabrooka Altaf[2], Kokab Kiran[3]

[1] Assistant Professor, Department of Economics, The Islamia University of Bahawalpur, Pakistan.
Email: tusawar.iftikhar@iub.edu.pk
[2] Lecturer, Southern Business School, Institute of Southern Punjab, Multan, Pakistan.
Email: mabrookabaloch@yahoo.com
[3] M.Phil. Scholar, Department of Economics, The Islamia University of Bahawalpur, Pakistan.
Email: kokabkiran6@gmail.com

ARTICLE INFO

Article History:
Received: May 05, 2020
Revised: June 18, 2020
Accepted: June 28, 2020
Available Online: June 30, 2020

Keywords:
GDP
EKC
CO2 emissions
Energy consumption
Panel data
ARDL
ASEAN countries

ABSTRACT

This study examined the effect of population, energy consumption, economic development on environment degradation in the context of ASEAN countries. For this purpose, the study used the panel data of nine ASEAN countries (Indonesia, Singapore, Malaysia, Brunei, Philippines, Cambodia, Thailand, Myanmar, and Vietnam) from 1995 to 2018 with the help of the World Development Indicators (WDI) dataset. Panel FMOLS and Panel ARDL methodology are used to examine the econometric model. ARDL results show that economic growth increases the emission of carbon dioxide which means economic development makes the environment unhealthy, moreover it confirmed the validity of the EKC hypothesis for ASEAN countries. There is a long-term positive impact of GDP and the consumption of energy on CO2 emission. In contrast, the impact of population growth is significant on the per capita emission of carbon dioxide. However, the emission of carbon dioxide hurts economic growth in the long run. Consequently, emission of carbon dioxide can be reduced, and economic growth can be sustainable by using low carbon emission technologies such as renewable energy.

Corresponding Author's Email: tusawar.iftikhar@iub.edu.pk

1. Introduction

One of the most critical global concerns is environmental sustainability which is increasing the public mandate. The developmental policies depend on economic growth which caused environmental degradation because the developmental processes or environmental production cost is the fundamental factor for environmental sustainability. However, natural resources are also an essential factor for climate change because several natural resources produced carbon dioxide emissions and have greenhouse effects. Environmental degradation occurred if the relationship between modern production/developmental processes and natural resources cannot be addressed in a proper manner (Grossman, 1995). Countries such as Malaysia have mentioned problems like the sustainability of the environment, security of energy and economic growth are contemporary important. The government of a few ASEAN countries such as Malaysia is trying to reduce the emission of carbon dioxide by up to 40% (United Nations Framework Convention on Climate Change, 2011). These countries also set the target for achieving a certain level of economic development with maintaining the environment (National Economic Advisory Council, 2009). Quality of environment and better economic growth are

mutually exclusive. For example, a group of researchers (Jorgenson & Wilcoxen, 1990) reported that if the price of fossil fuel increased, economic growth moves slower which affect environmental policies. On the other hand, many petroleum subsidies were given by the government, which encourages the consumption of additional energy (Abdullah, Salamatinia, Mootabadi, & Bhatia, 2009) which results boosts in the level of economic growth due to that subsidies.

Furthermore, the economic supremacy of ASEAN countries is now shifting from the agriculture sector towards the manufacturing and industrial sector that resulting in to increase in the use of energy over time (Hasan, 2007). The government policies show that economic development is now shifting towards another high energy consumption sector, i.e., the service and industrial sector. So, the target to improve the environment is only possible when the economy uses renewable energy resources instead of nonrenewable energy resources for production and manufacturing the goods.

According to WDI (World Bank, 2020), energy consumption was increased from 1995 to 2018 for Indonesia (664.4 to 870.9 kg per capita), Thailand (1041.3 to 1955.4 kg per capita), Malaysia (1687.4 to 3203.5 kg per capita), Singapore (5346.9 to 5221.8 kg per capita), Philippines (481.8 to 503.5 kg per capita), Vietnam (292.2 to 670.3 kg per capita), Myanmar (269 to 379.3 kg per capita), Cambodia (266.2 to 436.8 kg per capita), and Brunei Darussalam (7562.8 to 8673.1 kg per capita) Which is also confirmed from table1 and figure 1 and also confirmed that with the passage of time energy consumption also increased. And figure 2 shows that the energy consumption and emission of CO_2 have a positive relationship. This paper aims to identify the effect of population growth, consumption of energy, and GDP growth on the emission of carbon dioxide in ASEAN countries with the help of the dynamic OLS and ARDL approaches.

Table 1
Energy Consumption in selected 9 ASEAN countries

year	Brunei Darussalam	Cambodia	Indonesia	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
1995	7562.8	266.2	664.4	1687.4	269.0	481.8	5346.9	1041.3	292.2
2000	7157.1	280.7	735.9	2107.8	274.9	512.7	4634.7	1148.2	359.6
2005	6074.6	258.9	794.4	2558.5	304.3	450.1	5056.0	1513.5	492.1
2010	8337.5	370.3	877.1	2601.4	277.1	429.9	5006.6	1753.7	669.7
2015	8097.7	406.9	873.9	2991.6	344.9	463.7	5001.1	1980.3	662.1
2016	8385.4	411.9	878.9	2997.5	357.1	469.0	5061.5	1974.6	663.0
2017	8241.5	409.4	876.4	2994.5	351.0	466.3	5031.3	1977.5	662.5
2018	8313.5	410.6	877.6	2996.0	354.0	467.7	5046.4	1976.1	662.7

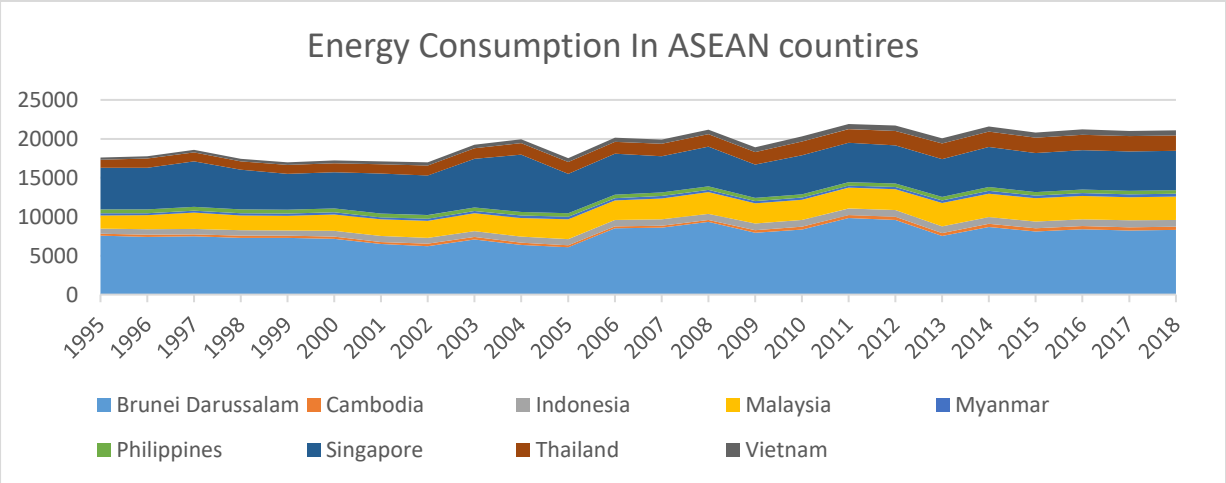

Figure 1: Energy Consumption in selected ASEAN countries

Figure 1 shows that Vietnam has the highest, and Thailand has the second-highest energy utilization, in particular, ASEAN countries from 1995 to 2018 after that Singapore, Philippines and Malaysia follow on.

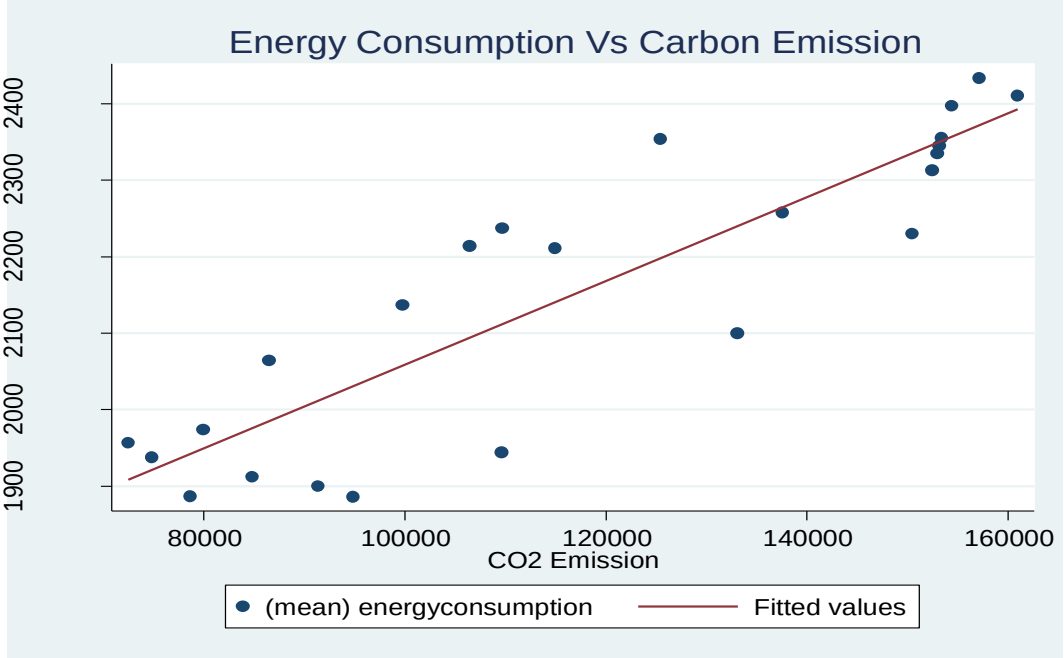

Figure 2: Relationship between Carbon emission and Energy consumption

It is represented in figure 2 that the relationship of emission of CO2 and energy use has a positive affiliation in the ASEAN, as mentioned earlier countries. This means that if energy consumption increases then the carbon emissions in ASEAN countries also increase.

2. Literature Review

Some recent studies increase the importance of renewable sources of energy and many researchers work in this domain. Many studies were published based on the relationship between economic development with the emission of carbon dioxide in developing as well as developed countries (Arouri, Youssef, M'henni, & Rault, 2012; Hossain, 2011; Pao & Tsai, 2011; Saboori, Sapri, & bin Baba, 2014). Mostly, the researchers investigated the EKC hypothesis and provide a simple solution for environmental and economic issues. The interlinkages between the economic expansion and emission of carbon dioxide varies from inverted u shaped, v-shaped, linear, or other types which depend on the focused country(s); i.e., USA (Menyah & Wolde-Rufael, 2010a; Soytas, Sari, & Ewing, 2007), India (Tiwari, 2011), South Korea (Baek & Kim, 2013), Turkey (Ozturk & Acaravci, 2010), China (Dean, Lovely, & Wang, 2005; Wang, Zhou, Zhou, & Wang, 2011), Bangladesh (Alam, Begum, Buysse, & Van Huylenbroeck, 2012), and ASEAN Countries (Saboori & Sulaiman, 2013).

Some researches confirmed U- shaped EKC hypothesis which directly reflects that the quality of the environment improved with the help growth of the growth which minimized carbon emission and improve the environment (Baek & Kim, 2013; Cole, Rayner, & Bates, 1997; Galeotti, Manera, & Lanza, 2009; Roberts & Grimes, 1997; Schmalensee, Stoker, & Judson, 1998; Selden & Song, 1994). Furthermore, many studies indicated that the EKC hypothesis was not valid, as degradation of the environment occurs with the growing economy (Clausen & York, 2008; Dietz & Adger, 2003; Ekins, 1997; Roca, Padilla, Farré, & Galletto, 2001).

Holtz-Eakin and Selden (1992) investigated the relationship between global warming predictions, greenhouse gases, emission of carbon dioxide and growth of the economy. The result showed that the population growth was increasing rapidly in the developing countries; therefore, the carbon dioxide emission was increasing. Furthermore, they found the rising curve was monotonic. Whereas, some group of researchers emphasizes that the relationship was non-monotonic (De Bruyn, van den Bergh, & Opschoor, 1998; Lantz & Feng, 2006; Shafik, 1994).

Ozturk and Acaravci (2010) inspected the casual and long-run linkage of employment ratio, energy utilization, emission of CO_2, and economic development in Turkey

over the period 1968-2005 with the help of ARDL testing. The result showed that the level of significance was 5% in the long run among the variables mentioned above. The energy utilization and emission of CO_2 had no fundamental association with the GDP while (Grossman, 1995; Shafik, 1994) found an N-shaped curve. Every research has its own merits and is conducted for the improvement of environmental balance and economy.

Rafiq and Alam (2010) studied the impact of economic development on the environment for 6 countries i.e., (India, Philippines, China, Indonesia, Brazil, and Turkey) and they found that the carbon dioxide emission was decreased with increasing income. All these countries are major renewable energy drivers. Therefore, carbon dioxide emissions were decreased. Omri and Nguyen (2014) investigated the consumption of renewables and their determinants and collected the dataset of 64 countries over the period 1990 to 2011. This study clarified that trade and emission of CO_2 were the major influences. Furthermore, a better environment must diminish the use of fossil fuels and use renewables instead.

Saboori, Sulaiman, and Mohd (2012) provide a brief description of economic growth and emission of CO_2 over the period 1980-2009 for Malaysia. A long-run EKC hypothesis was examined with the help of ARDL methodology, where the emission of CO_2 is an endogenous indicator. The results confirm an inverted U-shape association between economic growth and carbon emission in both the short and long run.

Ang (2008) investigates the emission of CO_2, consumption of energy, economic development with the help of Johansen cointegration, VECM-based Granger causality test. The results indicate that there exists a positive relationship between the emission of CO_2, energy consumption and economic development. However, this study did not include the EKC existence for GDP per capita. Gan and Li (2008) examined the relationship between energy consumption and emission of CO_2 with the help of ordinary least squares (OLS) estimation. The results confirm the significant effect of economic growth on environmental degradation. No unit-root test was used, which was the limitation of this study (Nelson & Plosser, 1982). While Azlina and Mustapha (2012) used Johansen cointegration and VECM Granger causality test, results conclude that there exists economic development and emission of CO_2 relationship. Furthermore, they confirmed that there exists a bidirectional relationship between both variables. The limitation of this study was the researchers selected an optimal number of lags with the Johansen technique which is highly sensitive for this purpose as well as the integration of mixed order was present (Gonzalo, 1994).

In most ASEAN countries, the major source of the energy sector is fossil fuel consumption which led to carbon dioxide emission. The energy produced with fossil fuel consumption was about 36% until 2004 around the globe (Nawaz, Azam, & Bhatti, 2019; Outlook, 2006). There are a lot of greenhouse gases other than carbon dioxide, but approximately 60% of the overall greenhouse effect is due to the emission of CO_2 gas. Therefore, the climate is changing, which in turn causes global warming. Therefore, it is indispensable to address this fundamental problem, and countries should find a way to reduce carbon dioxide emissions for minimizing the adverse effect of climate change.

Gan and Li (2008) examined and forecast Malaysian growth from 2004 to 2030 and concluded that GDP rise from US$ 107 billion to US$341.6 billion from 2004 to 2030 with a growth rate of 4.6%. Furthermore, they reported that industrial and production sector production increased as compared to the agriculture sector in Malaysia in the response period. Moreover, the researchers concluded that energy use also approximately increased by 4.3% with economic growth in that time period. The study concluded that the percentage of energy use is less than the growth, and it should be three times more than the expected energy consumption.

Ghosh (2010) examined the association between the development of the economy and the production of carbon dioxide for the Indian economy. They concluded that there exits bidirectional relationship exists among them in the long run. While in the short run there exists a uni-directional association among them which is also concluded by (Menyah & Wolde-Rufael, 2010b) in South Africa. Furthermore, Lotfalipour, Falahi, and Ashena (2010) also confirmed that there exists a bidirectional association for Iran. While Ozturk and Acaravci (2010) concluded that Economics growth does not depend on the consumption of

energy and carbon emission level in Turkey. Luzzati and Orsini (2009) examined the EKC hypothesis for 113 countries and the results concluded that the EKC hypothesis is not valid in those nations. Because there exists a positive relationship between economic development and the production of CO2 for Malaysia (Bakhtyar, Kacemi, & Nawaz, 2017).

The ASEAN nations are formed in 1967 and it consists of Thailand, Singapore, Philippines, Malaysia, and Indonesia countries and later Laos, Brunei Darussalam, Myanmar, Vietnam, and Cambodia are included in the ASEAN group. According to the report of Statista (2019), ASEAN countries had 647.74 million total population in 2018 which is (9% of the total global population). ASEAN is growing at a fast pace as compared with the world's economies. The GDP growth was 4.8% from the period 1994-1999 and increased to 6.5% in 2000-2008. Energy consumption was also increasing because of the industrialization and urbanization in this region. The consumption of energy increased with the growing population and GDP in 2030 by 4.4% (The Energy Data and Modelling Center, 2010). This growth is very high as compared to the other developed or developing countries (Tanaka, 2010). However, the carbon dioxide emission is also increasing similarly. Therefore, it is essential to identify the relationship and causality of ASEAN member countries. Saboori and Sulaiman (2013) inspected the linkage among economic development, CO_2 emission, and consumption of energy in the ASEAN region from 1971 to 2009. Granger causality and ARDL technique were applied along the VECM (Vector Error-Correction Model). The outcome reflects that there exists a positive association between the consumption of energy and carbon dioxide emission in the long and short run for every country. Further, they concluded that the elasticities of the short-run was less elastic as compared to the long run. The level of consumption of energy was decreasing, relating to the emission level of CO_2. The researcher also confirmed that there exists non-linear relation among growth of the economy and emission of CO_2 for Thailand and Singapore, which reflects the EKC hypothesis validity. According to Granger causality, the emission of CO_2 and consumption of energy has bi-directional causality for all countries.

After compiling all the literature, it is concluded that there is a mixed relationship among economic development carbon emission levels due to different econometrics models, variables and periods. However, this study will show the dynamic relationship among emission of CO_2, population growth, GDP per capita, and utilization of energy in nine ASEAN countries over the period 1995-2018. The rest of the study has a different section, like in section 3 detail variable description and methodology is discussed, section 4 described the impact of energy and population with supporting indicators to carbon emission level. And the final section is depending on the conclusion and policy recommendation of the study.

3. Data and Methodology

This study used panel data for nine ASEAN nations from 1995 to 2018, which are taken from the WDI (World Bank, 2020). The variables used for this study are consumption of energy (kg of oil equivalent per capita), GDP (growth), carbon dioxide emission (metric tons per capita), and population (growth). The model and the variables selected are discussed below.

This study depends on Cobb Douglas production function along with the constant return, which can be express the total output function at time t, which is shown below:

$$Y_{it} = F(K_{it}, AL_{it}) \quad (1)$$

Among them, Y_{it} is the growth of per capita GDP, $K_{it}$is the capital, and AL_{it} is the actual labour. Because it is generally believed that economic emissions are released from activities of the economy, the emission of CO_2 function is described as below:

$$CO2_{it} = vF(Y_{it}) \quad (2)$$

Their v represents a specific carbon dioxide emission rate in the production function. In the manufacturing process during energy combustion, the emission of carbon dioxide does not occur in the forms of capital. Carbon emission is significant because of the combustion of natural gas, coal, oil, and the manufacturing process of electricity from fossil

fuels. Therefore, total capital can be a component of a capital issue (K_e) and non-emitting capital (K_n) as presented below

$$K = K_e + K_n \quad (3)$$

Thus, the CO2 emission function can rewrite as:

$$CO2_{it} = \theta K_e(Y_{it}) \quad (4)$$

Since Y_{it} is a purpose of labour and capital; the growth of population can be considered representative. Besides, due to various human activities, the emission of CO_2 concentration has an increasing rate, and population growth has become an essential indicator in explaining CO2 emanation dynamics (Bongaarts, 1992). Thus, the formula will take the form:

$$CO2 = \beta_o + \beta_1 GDP_{it} + \beta_2 K_{p,it} + \beta_3 POP_{it} + \varepsilon_{it} \quad (5)$$

Grossman (1995) provided the carbon emission and GDP relationship, which was non-linear and can be seen in the following equation:

$$CO2 = \beta_o + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 EC_{p,it} + \beta_4 POP_{it} + \varepsilon_{it} \quad (6)$$

Before estimating the conditional distribution of the relationships, we first use the conventional least-squares dynamic panel (DOLS) method (Westerlund, 2008) and the panel's autoregressive lag model (ARDL) for co-integrated long-term and short-term models and a foundation of experience to perform a balanced relationship. For brevity, the empirical indicator of the equation can be expressed as:

$$CO2_{it} = \vartheta_o + \sum_{i=1}^{p} \vartheta_1 \Delta CO2_{i,t-1} + \sum_{i=0}^{p} \vartheta_2 \Delta GDP_{i,t-1} + \sum_{i=0}^{p} \vartheta_3 \Delta GDP_{it}^2 + \sum_{i=0}^{p} \vartheta_4 \Delta EC_{i,t-1} + \sum_{i=0}^{p} \vartheta_5 \Delta POP_{i,t-1} + \vartheta_6 CO2_{i,t-1} + \vartheta_7 GDP_{i,t-1} + \vartheta_8 \Delta GDP_{it}^2 + \vartheta_9 EC_{i,t-1} + \vartheta_{10} POP_{i,t-1} + \epsilon_{it} \quad (7)$$

According to equation 7, the dependent variable is carbon dioxide (metric tons) and exogenous variables. ϑ_o represents the coefficient of the equation, while $\vartheta_1 \; to \; \vartheta_{10}$represent the long and short-term impacts of independent variables on the emission of CO_2, and ϵ_{it}represents the white noise for ASEAN countries. In estimating the number of central units and the time t after cointegration, we made long and short-term estimates of the model based on FMOLS and ARDL panels.

3.1. Data Source

Annual panel data of 9 ASEAN nations of the time span of 1995 to 2018 has been taken from the WDI (World Bank, 2020)

4. Empirical Results

Table 2
Summary Statistics

Variables	CO2MT	GDP	LEC	POPG
Mean	4.772	5.354	7.012	1.487
Median	1.770	5.708	6.677	1.352
Maximum	24.627	14.526	9.194	5.322
Minimum	0.136	-13.127	5.527	-1.475
Std. Dev.	5.919	3.763	1.153	0.756
Skewness	1.608	-0.851	0.434	1.016
Kurtosis	4.884	6.175	1.786	7.144
Observations	216	216	216	216

As described in the methodology section, it is compulsory to verify the order of integration of the variables by unit root test (Kyung-So Im, Lee, & Tieslau, 2005; Kyung So Im, Pesaran, & Shin, 2003) before moving towards the cointegration level (Pesaran, Shin, & Smith, 2001). However, there are two reasons for the root unit analysis in this study.

Firstly, none of the variables exceeds the I(1) order of integration, and then not to just be enthusiastic about the Cointegration method but to justify the ARDL method application. Therefore, based on trends and constants, the methods of Levin Lin and the Chu and Lm Pesaran and Shin were used to test the order of integration (Elliott, Rothenberg, & Stock, 1992).

Table 3
Panel unit root test

Order	Level				First difference			
Test	Levin, Lin & Chu		Im, Pesaran & Shin		Levin, Lin & Chu		Im, Pesaran & Shin	
Variable	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
GDP	-6.402***	0.000	-6.259***	0.000				
CO2	-0.738	0.230	0.105	0.542	-4.922***	0.000	-6.624***	0.000
POP	-7.255***	0.000	-11.277***	0.000				
EC	0.977	0.836	1.022	0.847	-4.255***	0.000	-5.072***	0.000

*Note: ***, ** and * show 1%, 5% and 10% level of significance respectively.*

Table 3 shows that CO2 emissions are not stationary at I (0) and stationary at I (1). However, GDP is stationary at I(0). The unit root test also shows that the population growth rate is stationary at I(0). Similarly, energy consumption (per capita) is stationary at I(1) instead of I(0). Therefore, as reported in the unit's root test, the existence of this mixed order of integration confirmed to move towards (DOLS) and ARDL, rather than the traditional econometric method. Before the transition to ARDL and DOLS, the Pedroni cointegration test was used, which confirms the outcomes of ARDL and DOLS are shown in Tables 4 and 5.

Table 4
Cointegration and DOLS results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Pedroni Cointegration Test			-7.389	0.000
Pedroni Cointegration Test			-4.053	0.000
GDPG	-0.608***	0.112	-5.444	0.000
GDPG^2	0.052***	0.010	5.103	0.000
LEC	5.195***	1.165	4.461	0.000
POPG	1.913***	0.314	6.091	0.000
Model Diagnostics				
R-squared				0.985
Adjusted R-squared				0.970

$Note$: $***,**\ and\ *\ show\ 1\%, 5\%\ and\ 10\%\ level\ of\ significance\ respectively.$

Table 4, shows that the Pedroni cointegration test confirms the long-term relationship between the growth of the population with the consumption of energy as well as the growth of the economy with carbon dioxide emission. Dynamic Ordinary Least Square methodology (DOLS) is used to examine the impact of the square of GDP, GDP, and consumption of energy on the emission of carbon of ASEAN countries. It also shows that financial development hurts the production of carbon, while the square of GDP, consumption of energy, and population growth boost carbon emissions level.

If GDP is increased by one unit, carbon emissions are reduced by 60 metric tons and squared GDP will increase carbon emissions by 5% metric tons. In the case of consumption of energy, if the energy consumption increases by 1 unit, it leads to an increase of 5.1955% metric tons emissions of carbon and an increase of 1.913% metric tons of population emissions. The long- and short-term results are described in Table 4.

According to the (Pedroni, 1999) cointegration test, it confirmed that there exists cointegration in the model, which is also verified by the error correction term. It confirms that there exists a long-run relationship between population growth, use of energy, carbon dioxide emission and growth of an economy. The speed of adjustment per year is 29%. By taking a look at Table 5, one can see that there are statistical significance and negative impact of GDP on the carbon emission, which reflects that the increasing GDP per capita decreases the emission of CO_2 at the preliminary stage.

Table 5
Panel ARDL results

Long Run Equation				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
GDPG	-0.192**	0.054	-3.578	0.001
GDPG^2	-0.015**	0.006	-2.404	0.018
LEC	4.782**	1.778	2.690	0.009
POPG	2.015*	1.141	1.767	0.081
Short Run Equation				
COINTEQ01	-0.289**	0.124	-2.339	0.022
C	-9.754**	4.017	-2.428	0.017
@TREND	0.083	0.051	1.613	0.110
D(CO2MT(-1))	-0.353***	0.087	-4.085	0.000
D(CO2MT(-2))	-0.256**	0.096	-2.678	0.009
D(GDPG)	-0.069	0.074	-0.923	0.359
D(GDPG(-1))	-0.091	0.080	-1.136	0.259
D(GDPG^2)	0.005*	0.003	1.776	0.079
D(GDPG(-1)^2)	0.006	0.005	1.231	0.221
D(LEC)	1.321	1.537	0.859	0.393
D(LEC(-1))	1.054	1.485	0.709	0.480
D(POPG)	10.686	8.823	1.211	0.229
D(POPG(-1))	-6.960	6.108	-1.139	0.257

Note: ***,** *and* * *show* 1%, 5% *and* 10% *level of significance respectively.*

Furthermore, the square of GDP has also a negative and significant impact on the carbon emission level. It also confirms that there does not exist the EKC hypothesis in the case of ASEAN countries. Brock and Taylor (Bank, 2010) discussed that there are t3 important mechanisms that reflect the environment and economic growth relationship; firstly, the use of technology in the manufacturing process means or composition of manufacturing and the scale of manufacturing goods. Al Mamun, Sohag, Mia, Uddin, and Ozturk (2014) also revealed that the economic transition from industry to services has led to a reduction in the emission of CO_2 in low- and middle-income nations. The developed countries which have high income and OECD member countries have advanced technologies; there is also an increase in the emission of CO_2 (Al Mamun et al., 2014). Similarly, growth in a service sector economy emits more carbon dioxide than in other sectors (Alcántara & Padilla, 2009). Additionally, there is some literature about the developed countries who have a high income, but it doesn't mean that they are contributing more percentage in the carbon dioxide emission (Brock & Taylor, 2005; Dinda & Coondoo, 2006; Jalil & Mahmud, 2009; Managi & Jena, 2008; Nawaz et al., 2019).

The model also found that the growth of population estimates is positive and significant, which means the growth of population is the main reason for ASEAN's impact on CO_2 emissions. However, per capita consumption emissions of CO_2 have a substantial and increasing impact, since most ASEAN countries' CO2 productions are from energy, transport, and energy transport. This correlation is consistent with many other studies (Hossain, 2011; Soytas et al., 2007) and (Lotfalipour et al., 2010; Park & Lee, 2011). However, technological advances have reduced the intensity of emission of CO_2 by improving the efficiency of energy (Bloch, Rafiq, & Salim, 2012; Weber, Peters, Guan, & Hubacek, 2008; Yunfeng & Laike, 2010), with new carbon-free technologies (such as wind and nuclear energy) helping to reduce carbon emissions and carbon dioxide without damaging economic growth (Chen, Zhang, Xu, & Li, 2011).

GDP has statistically significant, and unfavourable, which shows that the increase in GDP growth decreases the emission of CO_2 in the early part or first quarter for the simple year. After taking a look at the economic growth history, we can conclude that the quadratic form of the LGDPC coefficient is not only significant but also negative, pointing out that the carbon dioxide emission aggravated during 1995-2018 with the increase in GDP growth. Therefore, the expansion of the manufacturing sector in a dramatic manner is because of this explanation finding. The results of primary to secondary shifting of economic growth are significant with the energy demand.

5. Conclusion

This study is equipped with numerous exciting findings. First, the relationship is long run among the population growth, consumption of energy, GDP growth, as well as the emission of CO_2 in the ASEAN countries. Second, there is no validity of the Kuznets environmental curve, and all approaches have u-shaped curves such as for Dynamic OLS and ARDL testing. Finally, the analysis shows that per capita carbon dioxide emission has an essential effect on the population growth rate. However, there is a long term effect of GDP and consumption of energy on carbon dioxide. However, CO_2 emission will harm economic development in the long run in ASEAN countries.

Generally, there is a decreasing trend of population growth while the increasing trend of use of energy and GDP in the ASEAN countries. Therefore, the increase of per capita CO_2 emission is because of the increase in energy utilization, the rapid growth of the economy, and the growing concern. The ASEAN countries are adopting the strategy of 5 fuel mixing diversification. The fossil fuel energy used in ASEAN countries has its full share in the total consumption of energy. Renewable energy, hydraulic energy, coal, natural gas, and oil are the five essential foundations of energy used in these countries.

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