

# THE EFFECTS OF FINANCIAL OPENNESS, CONSUMPTION OF RENEWABLE ENERGY AND CONSUMPTION OF FOSSIL FUELS, CO<sub>2</sub> EMISSIONS ON ECONOMIC GROWTH: AN EMPIRICAL EVIDENCE OF ASEAN COUNTRIES

Krisada Chienwattanasook<sup>1\*</sup>, Kittisak Jermsittiparsert<sup>2</sup>, Wasana Sinrungrtam<sup>3</sup>

<sup>1</sup>Faculty of Business Administration, Rajamangala University of Technology Thanyaburi, Thailand

<sup>2</sup>MBA School, Henan University of Economics and Law, China

<sup>3</sup>Faculty of Business Administration, Rajamangala University of Technology Thanyaburi, Thailand

Corresponding author: E-mail: krisada\_c@rmutt.ac.th

## ABSTRACT:

The foremost purpose of this paper is to examine the role of financial openness, consumption of renewable energy and fossil fuels, CO<sub>2</sub> emissions on economic growth (EG) of the ASEAN countries. Data were obtained from “The Chinn-Ito index (KAOPEN), World Bank Data (WDB), and International Energy Administration (IEA)” from 2001 to 2018. The “Generalized Moment of Method (GMM)” has been used to test the link among the understudy variables. The findings exposed that financial openness, consumption of renewable energy (RE), fuel energy, and CO<sub>2</sub> emissions are evidence of economic development in the countries that lead them towards economic growth. These findings recommended to the regulators and policymakers that they should develop and implement the policies that restricted the institution to utilize the energy resources efficiently that leads them towards economic growth and also maintain the quality environment in the country.

## Keywords:

Economic Growth, Financial Openness, Renewable Energy, Fossil Fuels, CO<sub>2</sub> emissions, ASEAN Countries

Article Received: 18 October 2020, Revised: 3 November 2020, Accepted: 24 December 2020

## INTRODUCTION

The area of EG link with RE consumption, fossil fuel consumption, CO<sub>2</sub> emissions, and financial openness have been getting substantial attention from the researchers due to human activities' impact on the environment (Asafu-Adjaye, 2000; Haseeb, Wattanapongphasuk, & Jermsittiparsert, 2019). Consequently, several studies have been conducted on the link among human activities and environmental degradation. In ASEAN countries, environmental degradation is increasing, and now it is double than the last two decades. The countries that are more polluted among the ASEAN countries are Malaysia, Thailand, Singapore, and Myanmar. These countries produce 43.2 percent of 350 million metric tons carbon emissions and approximately 85 million metric tons carbon. Other ASEAN countries emitting carbon approximately 10 million metric tons annually, such as Indonesia (41.1%), Brunei (31.7%), Vietnam (19.9%), Laos (15.6%),

Philippines (25.1%), and Cambodia (11.1%). Thus, fossil fuel consumption is one of the most significant causes of environmental degradation that is the outcome of EG. The FD and EG have a more significant influence on the growth in CO<sub>2</sub> emissions. Therefore, the debate regarding CO<sub>2</sub> emissions, EG, and financial development has obtained immense attention in the literature of energy economics globally (Saboori & Sulaiman, 2013a). However, the impact of EG and environmental diseases such as consumption of fuel and RE on the EG context is quite vital that depends on the efficient usage of energy and financial resources that are associated with the EG. Currently, consumption of fuel and renewable energy are the additional variables that are using in the literature very interesting because they are considered as vital tools to determine the EG. Both growth in financial sector and environmental degradation such CO<sub>2</sub> emission and high consumption of fuel and renewable energy have

essential role in the EG of the nation by using efficient ways of energy usage. There are several previous studies have been conducted on the link of trade openness, environmental degradation, and growth of the economy in different countries of the globe (Abidin, Haseeb, Azam, & Islam, 2015). Thus, two opposite schools of thought about the links among the fuel and RE consumption and EG. As far as the first school of thought is concern, the CO<sub>2</sub> emissions, high fuel, and renewable energy consumption become a significant cause of environmental degradation that wastes a lot of financial resources to green the environment and damage the EG as well. However, according to the second school of thought, the CO<sub>2</sub> emissions, high fuel, and RE consumption are the evidence of high development in the economy that leads them towards EG. Both growth in financial sector and environmental degradation such CO<sub>2</sub> emission and high consumption of fuel and renewable energy have essential role in the EG of the nation by using efficient ways of energy usage. Thus, CO<sub>2</sub> emissions, high fuel, and renewable energy consumption are considered as the critical determinants of EG in the country. Recently, three major views exist in the literature regarding the links among the CO<sub>2</sub> emissions, high fuel and RE consumption with EG. The first view is that the CO<sub>2</sub> emissions, high fuel, and RE consumption become a major cause of reduction in EG at initial stage, but after that the views are changed (Hussain, Mosa, & Omran, 2018). The second view is that CO<sub>2</sub> emissions, high fuel, and renewable energy consumption are the major cause of EG in the country. The third view is that the causal relationship exists among the CO<sub>2</sub> emissions, high fuel, and renewable energy consumption and EG of the country. Thus, it is found that CO<sub>2</sub> emissions, high fuel, and RE consumption are the major culprits of economic growth. Therefore, it is necessary for the EG that there should be more opportunities for the business, extensive use of technology, and high

but efficient usage of energy resources (Hussain, Mosa, & Omran, 2017).

Along with economic growth, environmental quality has also become a vital concern for the countries of the world, while it is a common thing that high EG influences adversely on environmental degradation. There are several previous studies was conducted on the link among energy consumption, environmental degradation, and EG and also required adequate policies regarding economic growth along with the improvement in environmental degradation. Nowadays, polices regarding the growth of the economy and quality of the environment needs to improve that also enhance the interest of the scholars on the links among environmental degradation and EG. Due to high growth in the economy, that also increases the consumption of the energy resources that result in environmental degradation and thus can be affected human life, health, and future generation of the globe. To control this situation in the world, recently, awareness about the quality of the environment increases since after 1970s among the environmental experts, policymakers, regulators, and economists (Hussain, Musa, & Omran, 2019). Resultantly, with the help of the efforts of the "United Nations Framework Convention on Climate Change (UNFCCC)," Kyoto Protocol Agreement was launched in 1997 to curb the CO<sub>2</sub> emissions, other GHG emissions, and global warming. The CO<sub>2</sub> emissions and other GHG emissions (such as sulfur oxides and nitrogen oxides) are the fundamental issues of environmental degradation and global warming; transportation is the origin of such GHG emissions (Hussain, Musa, & Omran, 2018). Thus, numerous literature was conducted on the CO<sub>2</sub> emissions related to EG and financial development. However, the polices regarding the protection of the environment in different countries are not up to the standard of the decline the GHG emissions in case of high economic growth and energy consumption situation that result in environmental degradation (Hussain et al.,

2012). It means if the energy resources are used in efficient ways during the growth of the economy then the quality of the environment improved. Thus, CO<sub>2</sub> emissions, high fuel, and renewable energy consumption are considered as the key determinants of EG in the country. Recently, three significant views exist in the literature regarding the links among the CO<sub>2</sub> emissions, high fuel and RE consumption with EG. The first view is that the CO<sub>2</sub> emissions, high fuel, and RE consumption become a significant cause of reduction in EG at initial stage, but after that the views are changed (Yildirim, Aslan, & Ozturk, 2014). The second view is that CO<sub>2</sub> emissions, high fuel, and renewable energy consumption are the major cause of EG in the country. Moreover, it is also fact that the regulation regarding the environment affected the growth of the economy, competitiveness, and employment of the world. Thus, the links among the quality of the environment and growth of the economy are very puzzling.

With reference to the growth of the economy and quality of the environment, this study organized an in-depth examination of the role of financial openness, consumption of RE and fossil fuels, CO<sub>2</sub> emissions on economic growth of the ASEAN countries. There are many studies conducted on the examination of links among the growth of the economy and quality of the environment with only CO<sub>2</sub> emissions, but present study adds the financial openness and consumption of fossil fuel and RE factor to evaluate the growth of the economy (Chandran & Tang, 2013). Furthermore, "Generalized Moment of Method (GMM)" approach has been used after checking the assumptions of "Ordinary Least Squares (OLS) approach" to test the link among the understudy variables. Previously, "fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS)" approaches have been used that were not provided the comprehensive results to the researchers, policymakers, and regulators. Thus, a lot question arises on the reliability of the findings drawn by

the previous literature on the links among the quality of the environment and the growth of the economy. This study provided reliable results that will facilitate the researchers, policymakers, and regulators in developing and implementing the policies regarding the quality of the environment and the growth of the economy. Thus, the present study fills the existing gap and also provided accurate and reliable results to the researchers, policymakers, and regulators in developing suitable policies for the quality of the environment and the growth of the economy. In addition, it is also fact that the regulation regarding the environment affected the growth of the economy, competitiveness, and employment of the world. Thus, the links among the quality of the environment and growth of the economy are not yet clear by the previous studies.

The growth rate in the ASEAN countries decreases with the passage of time, as shown in Table 1. The growth rate of GDP was 4.7 percent in Indonesia during the year 1990 to 2011, while with 0.2 percent increase it reached 4.9 percent from 2011 to 2035. In addition, the growth rate of GDP was 5.8 percent in Malaysia during the year 1990 to 2011 while with 1.8 percent decrease it reached 4.0 percent from 2011 to 2035. Moreover, the growth rate of GDP was 3.8 percent in Philippines during the year 1990 to 2011 while with 0.8 percent increase it reached 4.6 percent from 2011 to 2035. Furthermore, the growth rate of GDP was 4.2 percent in Thailand during the year 1990 to 2011 while with 0.0 percent increase it reached 4.2 percent from 2011 to 2035. Additionally, the growth rate of GDP was 6.7 percent in other ASEAN countries during the year 1990 to 2011 while with 1.9 percent decrease it reached 4.6 percent from 2011 to 2035. Finally, the growth rate of GDP was 5.0 percent in all the ASEAN countries during the year 1990 to 2011 while with 0.4 percent increase it reached 4.6 percent from 2011 to 2035. Table 1 highlighted the GDP growth rate of ASEAN countries from 1990 to 2035 are given below:

Country	1990-2011	2011-2020	2020-2035	2011-2035
Indonesia	4.7%	6.2%	4.2%	4.9%
Malaysia	5.8%	5.0%	3.4%	4.0%
Philippines	3.8%	5.6%	4.1%	4.6%
Thailand	4.2%	4.9%	3.8%	4.2%
Other ASEAN Countries	6.7%	4.9%	4.4%	4.6%
ASEAN Countries	5.0%	5.5%	4.1%	4.6%

**Table1:** GDP Growth Rate of ASEAN Countries from 1990 to 2035

The carbon emissions are increasing with an increase in the growth of the economy from 1975 to 2015. The global carbon emissions were only 15 percent in 1975 before the second oil shock, but after the second oil shock and before the dissolution of the Soviet Union the global carbon emission was only 18 percent in 1980. In addition, the global carbon emissions were only 19 percent in 1985 before the dissolution of Soviet Union, but in 1990 the global carbon emission was 22 percent. Moreover, the global carbon emissions were only 23 percent in 1995 before the dissolution of Soviet Union, but after the dissolution of Soviet Union and before the global economic downturn the global carbon emission was only 24 percent in 2000. Furthermore, the global carbon emissions were 27 percent in 2005 before the global economic downturn, but after the global economic downturn the global carbon emission was 29 percent in 2010. Finally, the global carbon emissions were 32 percent in 2015 after the global economic downturn. The global energy-related carbon emission is shown in Figure 2 given below:

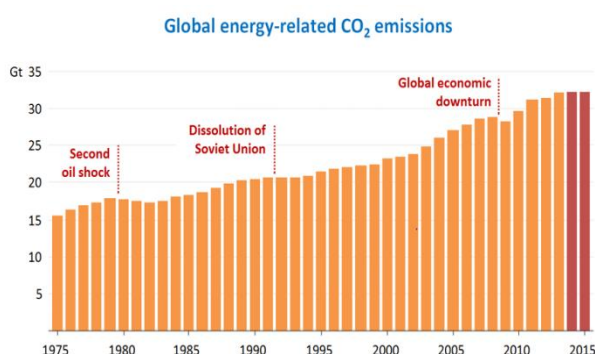
Thus, the above figures highlighted the global problem of high carbon emissions with growth in the economy. So, the question is: “what are the directional relationship between financial openness, renewable and fossil fuel consumption, CO2 emissions, and economic growth in the ASEAN countries”? Therefore, the major purpose of the paper is to examine the nexus among the CO2 emissions, financial openness, renewable, and fossil fuel consumption and EG in the ASEAN countries during the period of 2001 to 2018. This study provided reliable results that will facilitate the researchers, policymakers, and regulators in developing and implementing the policies regarding the quality of the environment and the growth of the economy. Finally, this study helps the policymakers and regulators in developing the new policies regarding the efficient use of energy resources to reduce the consumption of renewable as well as fossil fuel energy during the session of development and growth of the economy in the ASEAN countries.

**LITERATURE REVIEW**

This chapter provides the previous critical literature among the variables that are used in the study and their relationship with each other. The literature is given below in subsections:

**1.1 Economic Growth**

The EG means the growth in the level of production of society by applying the financial measures in the industries of the country (Ahmad et al., 2016). In addition, “economic growth refers



**Figure 1:** Global Energy-related CO<sub>2</sub> Emissions

to an increase in the total real' production of goods and services in an economy over time. Economic growth is usually measured in terms of an increase in GDP over time, or an increase in GDP per head of population to reflect its impact on living standards over time” (p-2004)(Salahuddin, Alam, Ozturk, & Sohag, 2018). Furthermore, However, the impact of financial growth and environmental diseases such as consumption of fuel and renewable energy on the EG context is quite vital that depends on the efficient usage of energy and financial resources that are associated with the EG. Currently, consumption of fuel and renewable energy are the additional variables that are using in the literature very interesting because they are considered as vital tools to determine the EG. Both growth in financial sector and environmental degradation such CO<sub>2</sub> emission and high consumption of fuel and renewable energy have essential role in the EG of the nation by using efficient ways of energy usage. There are several previous studies have been conducted on the link of trade openness, environmental degradation, and growth of the economy in different countries of the globe(Bende-Nabende, 2018). Additionally, the EG of the country means the improvemet in the productivieity level of the country(Liu, Zhang, & Bae, 2017; Shittu, Hassan, & Nawaz, 2018). The EG is the increament level in the GNP of the country that is due to the production level of the country(Tan & Tang, 2016). Similarly, EG refers to the enhancement in the processes of businesses that improve the level of output of the nation(Ketterer & Rodríguez-Pose, 2018). Likewise, the growth in the products due to the development in the process of production that results in the implementation of growth measures is said to be economic growth (Al-Mulali, Ozturk, & Lean, 2015). In addition, Both growth in financial sector and environmental degradation such CO<sub>2</sub> emission and high consumption of fuel and renewable energy have essential role in the EG of the nation by using efficient ways of energy usage(Shahbaz, Van Hoang, Mahalik, & Roubaud,

2017). Therefore, growth of the economy is the essential part of the development of the nation and this study take this topic under investigation and uses this variable as main variable of the paper.

### **1.2 Financial Openness**

The financial openness means free of the regulatory control of the one country government on the investment, trade, and other financial activities of other country. In addition, Along with economic growth, environmental quality has also become a vital concern for the countries of the world, while it is a common thing that high EG influences adversely on environmental degradation. There are several previous studies have been conducted on the link among energy consumption, environmental degradation, and economic growth and also required adequate policies regarding economic growth along with the improvement in environmental degradation.(Al-Mulali et al., 2015). Moreover, the approach of one country to the financial activities of other country without any regulatory restriction imposed by either regulation authorities or government. Furthermore, “building a departmental workplace culture that promotes this positive openness and transparency is the first step in fueling continued communication and collaboration among staff, which will ultimately lead to more effective and successful performance of the individuals and the business as a whole” (p-183)(Sinha & Pradhan, 2008). Additionally, financial openness is defined as the open the door of the financial activities by one country for the other countries by removing all the regulatory restrictions (Pradhan, Arvin, Hall, & Bahmani, 2014). Likewise, the removal of the regulatory restrictions from the financial events imposed by once government on the other countries of the world(Rasoulinezhad & Saboori, 2018). Therefore, financial openness is an essential part of the development of the nation and this study takes this topic under investigation and uses this variable as predictor in the paper.

### 1.3 Consumption of Renewable Energy

The consumption of RE refers to the use of energy that is developed from natural resources such as wind, waves, and sunlight (Al-Mulali, Fereidouni, Lee, & Sab, 2013). In addition, the use and consumption of the energy that is renewed after some time is said to be consumption or use of renewable energy (Shahbaz, Loganathan, Zeshan, & Zaman, 2015). Furthermore, the energy that is derived from the elements given by nature, such as heat, tides, and waves are said to be renewable energy, and this usage in the industry and transportation is said to be the consumption of renewable energy. Similarly, “renewable energy comes from a source that never runs out. In other words, its source lasts forever. Renewable energy comes from natural sources that Mother Nature continuously replaces on a human timescale. The term contrasts with non-renewable energy, which comes from sources that eventually deplete” (p-213) (Al-mulali, Fereidouni, & Lee, 2014). Likewise, the energy that comes into existence with the help of naturally long-lasting given gifts such as sunlight, winds, and heat and the usage of such energy in the production is known as consumption of renewable energy (Al-Mulali & Sab, 2012). Therefore, consumption of RE is an essential part of the development of the nation and this study takes this topic under investigation and uses this variable as predictor in the paper.

### 1.4 Consumption of Fossil Fuels

The usage of coal, gas, and petroleum products in the production of goods in the industry or the transportation sector is known as the consumption of fossil fuel. In addition, With reference to the growth of the economy and quality of the environment, this study organized an in-depth examination of the role of financial openness, consumption of renewable energy and fossil fuels, CO<sub>2</sub> emissions on economic growth of the ASEAN countries. There are many studies conducted on the examination of links among the growth of the economy and quality of the environment with only CO<sub>2</sub> emissions, but present

study adds the financial openness and consumption of fossil fuel and renewable energy factor to evaluate the growth of the economy (Papathanasopoulou, 2010). Moreover, the consumption of fossil fuel means the feasting of hydrocarbon fuel such as petroleum, gas, and coal in the industrial and transportation sector of the country. Similarly, “a hydrocarbon fuel, such as petroleum, coal, or natural gas, derived from the accumulated remains of ancient plants and animals and used as fuel. Carbon dioxide and other greenhouse gases generated by burning fossil fuels are considered to be one of the principal causes of global warming” (p-55) (Andres, Marland, Boden, & Bischof, 2000). Likewise, the indulging of fossil fuels such as carbon, gas, and petroleum in the business processes to develop the economy of the country is said to be the consumption of fossil fuel. (Junker & Liousse, 2008). Therefore, consumption of fossil fuel is an essential part of the development of the nation and this study takes this topic under investigation and uses this variable as predictor in the paper.

### 1.5 Carbon Emissions (CO<sub>2</sub>)

CO<sub>2</sub> means the emancipating carbon to the environment in the countries. It is emancipating from the transportation and industrial sectors of the society that alters the climate (Dietz & Stern, 2015). In addition, with reference to the growth of the economy and quality of the environment, this study organized an in-depth examination of the role of financial openness, consumption of renewable energy and fossil fuels, CO<sub>2</sub> emissions on economic growth of the ASEAN countries. There are many studies conducted on the examination of links among the growth of the economy and quality of the environment with only CO<sub>2</sub> emissions, but present study adds the financial openness and consumption of fossil fuel and renewable energy factor to evaluate the growth of the economy (Schandl et al., 2016). Moreover, carbon emissions are also known as the seepage of gas of greenhouse that exaggerated the atmosphere of the nation. The transportation,

corporations and industrial sectors are the main causes for the CO<sub>2</sub> in the country (Mossler, Bostrom, Kelly, Crosman, & Moy, 2017). Furthermore, “carbon dioxide (CO<sub>2</sub>) is a colorless, odorless, and non-poisonous gas formed by combustion of carbon and in the respiration of living organisms and is considered a greenhouse gas. Emissions mean the release of greenhouse gases and their precursors into the atmosphere over a specified area and period of time” (p-397) (Chau, Leung, & Ng, 2015). Similarly, CO<sub>2</sub> also means to the seepage of gas from corporation and industrial sector that is the consequence of EG and also injured the quality of environment severely (Inglesi-Lotz & Dogan, 2018). Likewise, carbon emission also means “the amount of greenhouse gases and specifically carbon dioxide emitted by something (such as a person's activities or a product's manufacture and transport) during a given period” (Dogan & Seker, 2016). Therefore, carbon emissions are an essential part of the development of the nation and need to control it to damage the climate, and this study takes this topic under investigation and uses this variable as predictor in the paper.

### **1.6 Financial Openness and Economic Growth**

The EG depends upon the financial openness of all the countries of the world. If the financial activities are open between the countries, then the EG increases and vice versa. In addition, the findings of the previous literature found positive link among the financial openness and EG of the countries. Moreover, as far as financial openness increases the EG of the country also improved and vice versa. Furthermore, financial openness is one of the vital elements of the economic growth of the countries (Menyah, Nazlioglu, & Wolde-Rufael, 2014). Similarly, EG of the country influenced by trade and other financial openness with other countries. Likewise, financial openness is the foremost factor for the growth of the economy in the world. However, if the financial activities are open between the countries then the economic growth decreases and vice versa. In addition, the findings of the previous literature

found negative link among the financial openness and economic growth of the countries. Moreover, as far as financial openness increases the EG of the country decreases and vice versa. Similarly, EG of the country adversely influenced by trade and other financial openness with other countries (Arouri, Uddin, Nawaz, Shahbaz, & Teulon, 2013). Thus, financial openness is an important measure to influence the growth of the economy of the world and based on previous literature; present study developed the following hypothesis:

**H1:** There is positive nexus among the financial openness and economic growth of the ASEAN countries.

### **1.7 Consumption of Renewable Energy and Economic Growth**

The EG depends upon the consumption of RE from the countries in the world. If the consumption of RE increases, then EG also increases and vice versa. In addition, the findings of the previous literature found positive link among the consumption of RE and EG of the countries. Moreover, as far as consumption of RE increases, the EG of the country also improved, and vice versa (Sebri & Ben-Salha, 2014). Furthermore, consumption of RE is one of the vital elements of the EG of the countries. Similarly, EG of the country influenced by the consumption of RE of the countries. Likewise, consumption of RE is the foremost factor for the growth of the economy in the world. However, if the consumption of RE increases then the EG decreases and vice versa (Ito, 2017). In addition, the findings of the previous literature found negative link among the consumption of RE and EG of the countries. Moreover, as far as consumption of RE increases, the EG of the country decreases, and vice versa (Bölük & Mert, 2014). Similarly, EG of the country adversely influenced by the consumption of RE of the countries. Thus, consumption of RE is the important measure to influence the growth of the economy of the world and based on previous

literature, and present study developed the following hypothesis:

**H2:** There is positive nexus among the consumption of renewable energy and the economic growth of the ASEAN countries.

### **1.8 Consumption of Fossil Fuels and Economic Growth**

The EG depends upon the consumption of fossil fuel from the countries in the world. If the consumption of fossil fuel increases, then EG also increases and vice versa. In addition, the findings of the previous literature found positive link among the consumption of fossil fuel and economic growth of the countries. Moreover, as far as consumption of fossil fuel increases, the EG of the country also improved, and vice versa (Nnaji, Chukwu, & Nnaji, 2013). Furthermore, consumption of fossil fuel is one of the vital elements of the EG of the countries. Similarly, EG of the country influenced by the consumption of fossil fuel of the countries. Likewise, consumption of fossil fuel is the foremost factor for the growth of the economy in the world (Saboori & Sulaiman, 2013b). However, if the consumption of fossil fuel increases then the EG decreases and vice versa. In addition, the findings of the previous literature found negative link among the consumption of fossil fuel and EG of the countries. Moreover, as far as consumption of fossil fuel increases, the EG of the country decreases and vice versa. Similarly, EG of the country adversely influenced by the consumption of fossil fuel of the countries (Say & Yücel, 2006). Thus, consumption of fossil fuel is the important measure to influence the growth of the economy of the world and based on previous literature, and present study developed the following hypothesis:

**H3:** There is positive nexus among the consumption of fossil fuel and the economic growth of the ASEAN countries.

### **1.9 Carbon Emissions and Economic Growth**

The EG depends upon the carbon emissions of the countries in the world. If carbon emissions increase, then the economic growth also increases and vice versa. In addition, the findings of the

previous literature found positive link among the carbon emissions and EG of the countries. Moreover, as far as carbon emissions increase, the EG of the country also improved and vice versa (Xiumei, Min, & Ming, 2011). Furthermore, carbon emissions are one of the vital elements of the EG of the countries. Similarly, EG of the country influenced by the carbon emissions of the countries. Likewise, carbon emissions are the foremost factor for the growth of the economy in the world. However, if the carbon emissions increase then the EG decreases and vice versa. In addition, the findings of the previous literature found negative link among carbon emissions and EG of the countries. Moreover, as far as carbon emissions increase, the EG of the country decreases and vice versa (Xiong, Yang, Huo, & Zhao, 2016). Thus, CO<sub>2</sub> emissions, high fuel, and renewable energy consumption are considered as the key determinants of EG in the country. Recently, three significant views exist in the literature regarding the links among the CO<sub>2</sub> emissions, high fuel and RE consumption with EG. The first view is that the CO<sub>2</sub> emissions, high fuel, and RE consumption become a significant cause of reduction in EG at initial stage, but after that the views are changed. Similarly, EG of the country adversely influenced by the carbon emissions of the countries. Thus, carbon emissions are an important measure to influence the growth of the economy of the world and based on previous literature, and present study developed the following hypothesis:

**H4:** There is positive nexus among the carbon emissions and economic growth of the ASEAN countries.

## **RESEARCH METHODS**

The foremost purpose of this paper is to examine the role of financial openness (FO), consumption of renewable energy (RE) and fossil fuels (FF), CO<sub>2</sub> emissions on economic growth (EG) of the ASEAN countries. Data were obtained from “The Chinn-Ito index (KAOPEN), World Bank Data (WDB), and International Energy Administration



(IEA).” The “Generalized Moment of Method (GMM)” has been used to test the link among the understudy variables. The equation for the GMM approach for given variables are under:

$$EG_{it} = \alpha_0 + \beta_1 FO_{it} + \beta_2 RE_{it} + \beta_3 FF_{it} + \beta_3 CO_{2it} + e_{it} \tag{1}$$

**1.10 Data**

Data were obtained from “The Chinn-Ito index (KAOPEN), World Bank Data (WDB), and International Energy Administration (IEA)” from 2001 to 2018. The following are the variables and measures that we used in the study.

(1) “Gross domestic product (GDP) in constant local currency units (LCU), available from World Bank Data (WDB).”

(2) “Renewable energy consumption (Renewable) in a Billion kilowatt-hour (kWh) from biomass, solar, hydropower, photovoltaic, wind, waste, and wave, available from the International Energy Administration (IEA)”

(3) “Fossil fuels energy consumption (Fossil) in a Billion kilowatt-hour (kWh) from coal, gas, and oil, available from the International Energy Administration (IEA).”

(4) “Carbon dioxide emissions (CO2) from the burning of fossil fuels (e.g., solid, liquid, gas fuels, and gas flaring) and the manufacture of cement (kilotons), available from World Bank Data (WDB).”

(5) “Financial openness index (Financial) that measures a country’s degree of capital account openness, available in The Chinn-Ito index (KAOPEN).”

**FINDINGS**

The findings consist of the descriptive statistics, “variance inflation factor” for multicollinearity, Skewness, and Kurtosis for normality, Breusch-Pagan for heteroscedasticity, Wooldridge for serial correlation, Hausman test for selecting the random and fixed-effect model and GMM estimator for hypotheses testing. The descriptive statistics highlighted the minimum and maximum values, standard deviation, and mean of the data. The descriptive statistics are mentioned in Table 2.

**Table 2: Descriptive Statistics**

Variable	Obs	Mean	Std. Dev.	Min	Max
RE	180	-.467	.520	-1.687	.587
FF	180	.612	.385	-.234	1.619
EG	180	1.657	.582	-.179	3.437
FO	180	1.169	.182	.645	1.756
CO <sub>2</sub>	180	.897	1.926	-9.180	4.060

The multicollinearity is the first assumption of the regression that is checked by the following equation:

$$R^2_{FO} FO_{it} = \alpha_0 + \beta_2 RE_{it} + \beta_3 FF_{it} + \beta_3 CO_{2it} + e_{it} \tag{2}$$

$$R^2_{RE} RE_{it} = \alpha_0 + \beta_1 FO_{it} + \beta_3 FF_{it} + \beta_3 CO_{2it} + e_{it} \tag{3}$$

$$R^2_{FF} FF_{it} = \alpha_0 + \beta_2 RE_{it} + \beta_1 FO_{it} + \beta_3 CO_{2it} + e_{it} \tag{4}$$

$$R^2_{CO_2} CO_{2it} = \alpha_0 + \beta_2 RE_{it} + \beta_3 FF_{it} + \beta_1 FO_{it} + e_{it} \tag{5}$$

$$j = R^2_{FO}, R^2_{RE}, R^2_{FF}, R^2_{CO_2}, \tag{6}$$

$$Tolerance = 1 - R^2_j VIF = \frac{1}{Tolerance} \tag{7}$$

The VIF shows that variables are not highly correlated with each other because tolerance is higher than 0.10, and VIF is less than 5.0. The “variance Inflation Factor” is mentioned in Table 3.

**Table 3: Variance Inflation Factor**

	VIF	1/VIF
FO	2.059	.486
RE	1.794	.557
FF	1.243	.805
CO <sub>2</sub>	1.057	.946
Mean VIF	1.538	.

The correlation among the variables also checked by the correlation matrix, and according to the matrix figures, variables are not highly correlated with each other because the values of matrix are less than 0.80. The correlation matrix is mentioned in Table 4.

**Table 4: Correlation Matrix**

Variables	FO	RE	EG	FF	CO <sub>2</sub>
FO	1.000				
RE	0.635	1.000			
EG	-0.741	-0.646	1.000		
FF	0.031	-0.158	0.291	1.000	
CO <sub>2</sub>	-0.429	-0.189	0.483	-0.041	1.000

The normality of data is checked by Skewness and Kurtosis test, and according to the figures, the data of EG, FO, and RE are normally distributed, but the data FF and CO<sub>2</sub> are not normally

distributed. However, the normality does not affect the outcomes if data were large, and in the case of this study, data is large (more than 100 observations). The Skewness and Kurtosis test are mentioned in Table 5.

**Table 5:Skewness and Kurtosis Test**

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj_chi2(2)	Prob>chi2
EG	180	0.172	0.046	5.720	0.057
FO	180	0.586	0.493	0.780	0.679
RE	180	0.203	0.272	2.870	0.238
FF	180	0.000	0.000	33.490	0.000
CO <sub>2</sub>	180	0.000	0.000	.	0.000

The homoscedasticity is the third assumption of regression, and this is checked by the Breusch-Pagan test, and according to the figure, data has

heteroscedasticity problem and is fixed by using the GMM estimator. In addition, the serial correlation is the fourth assumption of regression, and this is checked by the Wooldridge test, and according to the figure data has serial correlation problem and is fixed by also using the GMM estimator.

The results of fixed and random effect models are given below in Tables 6 and 7. According to results, the positive association among the FO, RE, FF, CO<sub>2</sub>, and EG of the ASEAN countries.

**Table 6:Fixed Effect Model**

EG	Coef.	St.Err.	t-value	p-value	L.L	U.L	Sig
FO	1.005	.007	154.03	.000	1.018	.993	***
RE	.018	.008	2.24	.000	.013	.017	***
FF	1.058	.016	66.48	.000	1.026	1.089	***
CO <sub>2</sub>	.034	.002	20.90	.000	.031	.037	***
Constant	-.081	.021	-3.94	.000	-.121	-.040	***
R-squared		0.997		Prob > F		0.000	

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

**Table 7:Random Effect Model**

EG	Coef.	St.Err.	t-value	p-value	L.L	U.L	Sig
FO	1.007	.006	160.42	.000	1.020	.995	***
RE	.019	.008	2.23	.000	.013	.017	***
FF	1.05	.014	72.85	.000	1.022	1.079	***
CO <sub>2</sub>	.034	.001	22.84	.000	.031	.037	***
Constant	-.073	.02	-3.73	0	-.111	-.035	***
R-squared within		0.997		R-squared between		0.997	

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

The Hausman test shows that the appropriate model is a random effect because the prob. value is higher than 0.05. The Hausman test is mentioned in Table 8.

**Table 8:Hausman Test**

	Coef.
Chi-square test value	2.778
P-value	.596

The GMM estimator shows that all the predictors such as FO, RE, FF, and CO<sub>2</sub> have positive links with the EG of the ASEAN countries because the outcomes show that positive sign the coefficient,

t-statistics are higher than 1.64 and probability values are less than 0.05. The GMM estimator is mentioned in Table 9.

EG	Coef.	St.Err.	t-value	p-value	L.L	U.L	Sig
L.EG	.029	.011	2.59	.010	.007	.052	***
FO	.985	.009	106.08	.000	1.003	.967	***
RE	.028	.012	2.33	.000	.011	.052	***
FF	1.127	.046	24.36	.000	1.037	1.218	***
CO <sub>2</sub>	.039	.005	8.28	.000	.029	.048	***
Constant	-.219	.046	-4.74	.000	-.309	-.128	***

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

**Table 9: GMM Estimator**

**DISCUSSIONS AND CONCLUSIONS**

The foremost purpose of this paper is to examine the role of financial openness, consumption of RE and fossil fuels, CO<sub>2</sub> emissions on economic growth (EG) of the ASEAN countries. The findings naked that the positive link of financial openness, consumption of RE, consumption of fossil fuels, carbon emissions with EG of ASEAN countries. Financial openness can enhance the financial activities of the country that increase EG. Moreover, the consumption of RE, fossil fuels, and CO<sub>2</sub> are evidence of high EG in the country. Therefore, current study concluded that if the trade is free with other countries and the consumption of fossil fuels and renewable energy is high and carbon emissions are increases in the country then the country will grow economically. Finally, the current study has some suggestions and recommendations for the researchers and policymakers and also has some limitations. This study suggested to the researchers that they must add more years under investigation because this study takes only eighteen years for examination. In addition, current research also suggested to the prospective scholars that they must include more factors that affecting the economic growth of the country. Moreover, further scholars should also include countries other than ASEAN countries in their examination. Finally, this study recommended to the regulators and policymakers that they should develop policies that not only enhance economic growth but also improve the quality of the climate. The high growth of the economy increases the consumption of fossil fuels, renewable energy and carbon emissions that

affected severely the climate of the country. Thus, there is a need for policies that enhance the efficient use of energy resources, which help to increase the quality of the climate along with economic growth.

**REFERENCES**

[1] Abidin, I. S. Z., Haseeb, M., Azam, M., & Islam, R. (2015). Foreign direct investment, financial Development, international trade and energy consumption: Panel data evidence from selected ASEAN Countries. *International Journal of Energy Economics and Policy*, 5(3), 841-850.

[2] Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., & Liu, Y. (2016). Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy. *Energy Policy*, 96, 131-143. <https://doi.org/10.1016/j.enpol.2016.05.032>

[3] Al-mulali, U., Fereidouni, H. G., & Lee, J. Y. (2014). Electricity consumption from renewable and non-renewable sources and economic growth: Evidence from Latin American countries. *Renewable and Sustainable Energy Reviews*, 30, 290-298. <https://doi.org/10.1016/j.rser.2013.10.006>

[4] Al-Mulali, U., Fereidouni, H. G., Lee, J. Y., & Sab, C. N. B. C. (2013).

- Examining the bi-directional long run relationship between renewable energy consumption and GDP growth. *Renewable and Sustainable Energy Reviews*, 22, 209-222. <https://doi.org/10.1016/j.rser.2013.02.005>
- [5] Al-Mulali, U., Ozturk, I., & Lean, H. H. (2015). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. *Natural Hazards*, 79(1), 621-644.
- [6] Al-Mulali, U., & Sab, C. N. B. C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries. *Energy*, 39(1), 180-186. <https://doi.org/10.1016/j.energy.2012.01.032>
- [7] Andres, R. J., Marland, G., Boden, T., & Bischof, S. (2000). Carbon dioxide emissions from fossil fuel consumption and cement manufacture, 1751-1991, and an estimate of their isotopic composition and latitudinal distribution. *The carbon cycle*, 53-62.
- [8] Arouri, M., Uddin, G. S., Nawaz, K., Shahbaz, M., & Teulon, F. (2013). Causal linkages between financial development, trade openness and economic growth: Fresh evidence from innovative accounting approach in case of Bangladesh. *Ipag Business School, Working Paper*, 2013-2037.
- [9] Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy Economics*, 22(6), 615-625. [https://doi.org/10.1016/S0140-9883\(00\)00050-5](https://doi.org/10.1016/S0140-9883(00)00050-5)
- [10] Bende-Nabende, A. (2018). FDI, regionalism, government policy and endogenous growth: a comparative study of the ASEAN-5 economies, with development policy implications for the least developed countries: Routledge.
- [11] Bölük, G., & Mert, M. (2014). Fossil & renewable energy consumption, GHGs (greenhouse gases) and economic growth: Evidence from a panel of EU (European Union) countries. *Energy*, 74, 439-446. <https://doi.org/10.1016/j.energy.2014.07.008>
- [12] Chandran, V., & Tang, C. F. (2013). The impacts of transport energy consumption, foreign direct investment and income on CO2 emissions in ASEAN-5 economies. *Renewable and Sustainable Energy Reviews*, 24, 445-453. <https://doi.org/10.1016/j.rser.2013.03.054>
- [13] Chau, C., Leung, T., & Ng, W. (2015). A review on life cycle assessment, life cycle energy assessment and life cycle carbon emissions assessment on buildings. *Applied energy*, 143, 395-413. <https://doi.org/10.1016/j.apenergy.2015.01.023>
- [14] Dietz, S., & Stern, N. (2015). Endogenous growth, convexity of damage and climate risk: how Nordhaus' framework supports deep cuts in carbon emissions. *The Economic Journal*, 125(583), 574-620. <https://doi.org/10.1111/ecoj.12188>
- [15] Dogan, E., & Seker, F. (2016). The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. *Renewable and Sustainable Energy Reviews*, 60, 1074-1085.

- <https://doi.org/10.1016/j.rser.2016.02.006>
- [16] Haseeb, M., Wattanapongphasuk, S., & Jermittiparsert, K. (2019). Financial Development, Market Freedom, Political Stability, Economic Growth and CO2 Emissions: An Unexplored Nexus in ASEAN Countries. *Contemporary Economics*, 13(3), 363-374. DOI: 10.5709/ce.1897-9254.319.
- [17] Hussain, M. S., Mosa, M. M., & Omran, A. (2017). The Mediating Impact of Profitability on Capital Requirement and Risk Taking by Pakistani Banks. *Journal of Academic Research in Economics*, 9(3), 433-443.
- [18] Hussain, M. S., Mosa, M. M., & Omran, A. (2018). The impact of owners behaviour towards risk taking by Pakistani Banks: Mediating role of profitability *Journal of Academic Research in Economics*, 10(3), 455-465.
- [19] Hussain, M. S., Musa, M. M., & Omran, A. (2019). The Impact of Regulatory Capital on Risk Taking By Pakistani Banks. *SEISENSE Journal of Management*, 2(2), 94-103. <https://doi.org/10.33215/sjom.v2i2.124>
- [20] Hussain, M. S., Musa, M. M. B., & Omran, A. A. (2018). The Impact of Private Ownership Structure on Risk Taking by Pakistani Banks: An Empirical Study. *Pakistan Journal of Humanities and Social Sciences*, 6(3), 325-337.
- [21] Hussain, M. S., Ramzan, M., Ghauri, M. S. K., Akhtar, W., Naeem, W., & Ahmad, K. (2012). Challenges and failure of Implementation of Basel Accord II and reasons to adopt Basel III both in Islamic and conventional banks. *International Journal of Business and Social Research*, 2(4), 149-174.
- [22] Inglesi-Lotz, R., & Dogan, E. (2018). The role of renewable versus non-renewable energy to the level of CO2 emissions a panel analysis of sub-Saharan Africa's Big 10 electricity generators. *Renewable energy*, 123, 36-43. <https://doi.org/10.1016/j.renene.2018.02.041>
- [23] Ito, K. (2017). CO2 emissions, renewable and non-renewable energy consumption, and economic growth: Evidence from panel data for developing countries. *International Economics*, 151, 1-6. <https://doi.org/10.1016/j.inteco.2017.02.001>
- [24] Junker, C., & Liousse, C. (2008). A global emission inventory of carbonaceous aerosol from historic records of fossil fuel and biofuel consumption for the period 1860–1997. *Atmospheric Chemistry and Physics*, 8(5), 1195-1207.
- [25] Ketterer, T. D., & Rodríguez-Pose, A. (2018). Institutions vs. 'first-nature' geography: What drives economic growth in Europe's regions? *Papers in Regional Science*, 97, S25-S62. <https://doi.org/10.1111/pirs.12237>
- [26] Liu, X., Zhang, S., & Bae, J. (2017). The impact of renewable energy and agriculture on carbon dioxide emissions: investigating the environmental Kuznets curve in four selected ASEAN countries. *Journal of cleaner production*, 164, 1239-1247. <https://doi.org/10.1016/j.jclepro.2017.07.086>
- [27] Menyah, K., Nazlioglu, S., & Wolde-Rufael, Y. (2014). Financial development, trade openness and economic growth in African countries: New insights from a panel causality approach. *Economic Modelling*, 37, 386-394.

- <https://doi.org/10.1016/j.econmod.2013.11.044>
- [28] Mossler, M. V., Bostrom, A., Kelly, R. P., Crosman, K. M., & Moy, P. (2017). How does framing affect policy support for emissions mitigation? Testing the effects of ocean acidification and other carbon emissions frames. *Global environmental change*, 45, 63-78. <https://doi.org/10.1016/j.gloenvcha.2017.04.002>
- [29] Nnaji, C. E., Chukwu, J. O., & Nnaji, M. (2013). Electricity Supply, Fossil fuel Consumption, Co2 Emissions and Economic Growth: Implications and Policy Options for Sustainable Development in Nigeria. *International Journal of Energy Economics and Policy*, 3(3), 262-271.
- [30] Papathanasopoulou, E. (2010). Household consumption, associated fossil fuel demand and carbon dioxide emissions: the case of Greece between 1990 and 2006. *Energy Policy*, 38(8), 4152-4162. <https://doi.org/10.1016/j.enpol.2010.03.043>
- [31] Pradhan, R. P., Arvin, M. B., Hall, J. H., & Bahmani, S. (2014). Causal nexus between economic growth, banking sector development, stock market development, and other macroeconomic variables: The case of ASEAN countries. *Review of Financial Economics*, 23(4), 155-173. <https://doi.org/10.1016/j.rfe.2014.07.002>
- [32] Rasoulinezhad, E., & Saboori, B. (2018). Panel estimation for renewable and non-renewable energy consumption, economic growth, CO 2 emissions, the composite trade intensity, and financial openness of the commonwealth of independent states. *Environmental Science and Pollution Research*, 25(18), 17354-17370.
- [33] Saboori, B., & Sulaiman, J. (2013a). CO2 emissions, energy consumption and economic growth in Association of Southeast Asian Nations (ASEAN) countries: A cointegration approach. *Energy*, 55, 813-822. <https://doi.org/10.1016/j.energy.2013.04.038>
- [34] Saboori, B., & Sulaiman, J. (2013b). Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets curve in Malaysia. *Energy Policy*, 60, 892-905. <https://doi.org/10.1016/j.enpol.2013.05.099>
- [35] Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO2 emissions in Kuwait. *Renewable and Sustainable Energy Reviews*, 81, 2002-2010. <https://doi.org/10.1016/j.rser.2017.06.009>
- [36] Say, N. P., & Yücel, M. (2006). Energy consumption and CO2 emissions in Turkey: empirical analysis and future projection based on an economic growth. *Energy Policy*, 34(18), 3870-3876. <https://doi.org/10.1016/j.enpol.2005.08.024>
- [37] Schandl, H., Hatfield-Dodds, S., Wiedmann, T., Geschke, A., Cai, Y., West, J., . . . Owen, A. (2016). Decoupling global environmental pressure and economic growth: scenarios for energy use, materials use and carbon emissions. *Journal of cleaner production*, 132, 45-56.

- <https://doi.org/10.1016/j.jclepro.2015.06.100>
- [38] Sebri, M., & Ben-Salha, O. (2014). On the causal dynamics between economic growth, renewable energy consumption, CO2 emissions and trade openness: Fresh evidence from BRICS countries. *Renewable and Sustainable Energy Reviews*, 39, 14-23. <https://doi.org/10.1016/j.rser.2014.07.033>
- [39] Shahbaz, M., Loganathan, N., Zeshan, M., & Zaman, K. (2015). Does renewable energy consumption add in economic growth? An application of auto-regressive distributed lag model in Pakistan. *Renewable and Sustainable Energy Reviews*, 44, 576-585. <https://doi.org/10.1016/j.rser.2015.01.017>
- [40] Shahbaz, M., Van Hoang, T. H., Mahalik, M. K., & Roubaud, D. (2017). Energy consumption, financial development and economic growth in India: New evidence from a nonlinear and asymmetric analysis. *Energy Economics*, 63, 199-212. <https://doi.org/10.1016/j.eneco.2017.01.023>
- [41] Shittu, W.O., Hassan, S., & Nawaz, M.A. (2018). The nexus between external debt, corruption and economic growth: Evidence from five SSA countries. *African Journal of Economic and Management Sciences*, 9(3), 319-334. <https://doi.org/10.1108/AJEMS-07-2017-0171>
- [42] Sinha, C., & Pradhan, N. C. (2008). *India's financial openness and integration with Southeast Asian countries: an analytical perspective*. Press & Communications CH 4002 Basel, Switzerland, 181.
- [43] Tan, B. W., & Tang, C. F. (2016). Examining the causal linkages among domestic investment, FDI, trade, interest rate and economic growth in ASEAN-5 countries. *International Journal of Economics and Financial Issues*, 6(1), 214-220.
- [44] Xiong, C., Yang, D., Huo, J., & Zhao, Y. (2016). The Relationship between Agricultural Carbon Emissions and Agricultural Economic Growth and Policy Recommendations of a Low-carbon Agriculture Economy. *Polish Journal of Environmental Studies*, 25(5). <https://doi.org/10.15244/pjoes/63038>
- [45] Xiumei, S., Min, Z., & Ming, Z. (2011). Empirical study on the relationship between economic growth and carbon emissions in resource-dependent cities based on vector autoregression model. *Energy Procedia*, 5, 2461-2467. <https://doi.org/10.1016/j.egypro.2011.03.423>
- [46] Yildirim, E., Aslan, A., & Ozturk, I. (2014). Energy consumption and GDP in ASEAN countries: Bootstrap-corrected panel and time series causality tests. *The Singapore Economic Review*, 59(02), 1450010. <https://doi.org/10.1142/S021759081450106>