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Determinants of CO2 Emissions in the ASEAN Economies: The Role of Renewable and Non-Renewable Energy

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ABSTRACT

Environmental protection is a concerning problem globally; several studies examined the factors that hurt the environment by examining the factors that boost the carbon emission level in recent decades. Selection of the data and econometric models is the highlighted issue in the current study because most studies used over energy consumption, and there is a problem of selection assessment techniques. Most of all, previous studies used general econometric models to measure the determinants of environmental degradation. So, this study fills the gap revealed in the past studies while using the essential indicators like trade openness, income, non-renewable and renewable energy on carbon emissions in the presence of EKC (Kuznets environmental curve) for the ASEAN economies from the time spam 2000 to 2018, by using panel ARDL, Pooled Mean Group (PMG) estimation techniques. The results of the PMG estimator confirm the presence of the EKC hypothesis in selected ASEAN countries. Furthermore, Trade and renewable energy minimize carbon dioxide emissions, whereas non-renewable upsurges CO2 emissions. The outcomes also revealed cointegration amongst carbon emissions and renewable energy and one-way causation found from income to CO2 productions, non-renewable energy to carbon emissions, and trade openness toward carbon dioxide emissions. Moreover, it concluded that ASEAN states that the government should advise the industries and all sectors to modify their energy sources from non-renewable energy sources to renewable energy sources because it helps increase energy and economic growth in reducing carbon emissions level.

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1. Introduction

Environmental pollution is among the leading global question due to the rise of greenhouse gas emissions (GHGs). Many countries just sign the Kyoto protocol, with some binding obligations; ASEAN countries are one. The first period of the Kyoto protocol aimed at

greenhouse gas emissions decreased by 8% related to 1990 to 2012, even different planes targeted by all the members (EEA, 2014) nations. However, many of them were unable to meet the planned target, but as a whole, ASEAN countries at the end of the first specific period had an average of 11.8% decrease in emissions of greenhouse gases. In the second period by the Doha Amendment, the Kyoto protocol has been renewed from the time period from 2013 to 2020. In 2020 an average of 20% reduced greenhouse gases compared to 1990 committed by the ASEAN countries.

Moreover, the ASEAN countries are predicted to raise the number of renewables in energy by more than 20% in 2020 (EEA, 2013). The realization of commitment plays the leading role but much harder to decrease environmental pollution in ASEAN countries' second commitment for future projects by 2030. According to (EEA, 2014), the main reason for the decrease in the emission level is to raise the mix of renewable energy. It is also suggested that there should be an adverse influence of non-renewable energy rather than renewable energy, which increased the amount of greenhouse gas emissions. Therefore, the main object of the present study is to check that whether the decrease in non-renewable energy and increase in renewable energy is economically or statistically meaningful for explaining the decrease in GHGs for ASEAN countries or not?

The present research is based on the standard and well known EKC (environmental Kuznets curve) to examine the impact of non-renewable and renewable energy on carbon emissions (a proxy of greenhouse gas emissions). EKC explains that an increase in the gross domestic product (GDP) at a specific level subsidizes CO2 emissions, and after that, it decreases the emission level. On the other hand, according to the EKC hypothesis, carbon emission, GDP, Square of GDP, and energy consumption regressed on Economic development (Apergis & Payne, 2009; Bölük & Mert, 2015; Farhani & Shahbaz, 2014). Some other empirical studies explained that trade openness might also define the carbon emissions by dealing with omitted variables, adapted the EKC model with the openness of trade-in EKC's primary model. Dogan and Turkekul (2016); Halicioglu (2009); Jebli, Youssef, and Ozturk (2016) through scale, composition, and technique effects trade openness can affect carbon emission by an increase in trade openness. (Farhani, Chaibi, & Rault, 2014) explained scale effect, which is the rise in GDP, is related to the rise in trade, higher pollution, and higher energy consumption.

The composition effect indicates that an economy focuses on inventing some goods by implying comparative advantage and that production based on whether goods are energy-intensive polluted sectors or not is based on the increase in trade that can raise or decrease the pollution. In the last, system effect states to technology spillover over trade movement among economies, besides therefore environment improvement for producing goods may due to the implementation of environmentally-friendly technologies. It is detected that trade openness may be harmful and positive on the environment, depending on which one is dominated. In ASEAN countries, trade openness explains emissions levels from 50% in 1980 to 80% in 2014 (World Bank, 2020). After following the previous studies, the present research analyzed the relationship between renewable and non-renewable energy, CO2emissions, trade openness, gross income, and quadratic gross income (Environmental Kuznets Curve) EKC for ASEAN regions. Table 1 and figure 1 show the connection between the carbon emission and GDP growth of selected ASEAN countries.

Table 1
Time Average of CO2 emission and GDP of ASEAN countries

Country	Avg (CO2)	Avg (GDP)
Brunei Darussalam	20.5509	10.2779
Cambodia	0.340701	6.54341
Indonesia	1.67491	7.64046
Malaysia	7.21213	8.90891
Myanmar	0.364657	6.30465
Philippines	0.956038	7.50303
Singapore	9.2266	10.5949
Thailand	4.10528	8.30799
Vietnam	1.49569	6.98721

Table 1 shows the average carbon emission and economic growth in selected ASEAN countries using 2000 to 2018. Brunei Darussalam has the highest carbon emission in all selected ASEAN countries: 20.5509 metric tons and the second-highest average economic growth. At the same time, Cambodia has the lowest carbon emission with average economic growth.

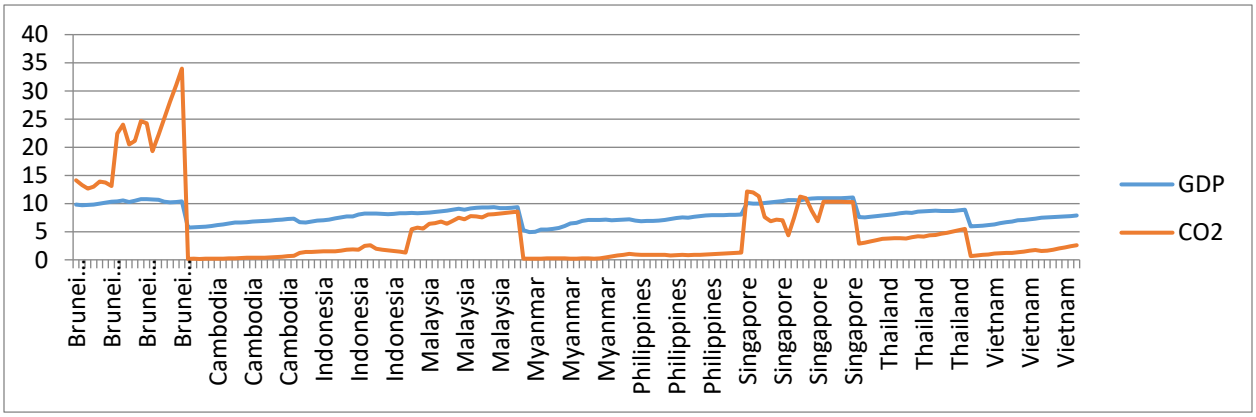

Figure 1:ASEAN countries Carbon emission and economic growth

Graph 1 shows that a positive affiliation between CO2 emission and economic growth. For example, with time, Cambodia, Malaysia, Myanmar, Philippines, Thailand, and Vietnam have a positive association with economic growth and carbon emission because they both move in the same direction, and Brunei Darussalam Singapore fluctuate. They moved in both directions like an increase and decreased both the trend in 2000 to 2018 years.

The present study uses different influences of energy-environment-growth literature. The literature review part of this study showed that most previous studies use in their research cumulative consumption of energy and, therefore, not successfully recognize the influence of energy use by using renewable and non-renewable energy sources. The influence of gross income, trade liberalization, non-renewable and renewable energy on carbon emission is the first attempt and the first object of this study using the modified EKC framework for the ASEAN countries from 1980-2012. So far, a study examined the special effects of renewable, non-renewable energy then income effect towards the pollution for the panel of ASEAN states in the presence of environmental Kuznets curve from the time 1990-2008 (Bölük & Mert, 2014), and the finding of the study proved that both renewable and non-renewable studies raise CO2 emissions. The result of the study was not according to the expectations. There were small sample sizes, and small omitted variables are used for possible reasons. All previous studies are based on the panel estimation technique for the estimation of environmental literature. In this study, we used the multiple panel unit root test, which is Lm

Pesaran. Fisher and PP unit root test to confirm the order of integration. After that, they applied the panel ARDL econometrics methodology to estimate the long and short-run estimates empirically. This study's results are suitable and reliable within the presence of proper econometrics methodology. The second section explains the literature review, and the third one defines the model and data, the fourth section explained the empirical outcomes of the study, and the last section concludes the conclusion and policy recommendations.

2. Literature review

These empirical studies confirmed that energy consumption significantly increases in countries where financial developments are fast. These results are verified by (Shahbaz, Lean, & Shabbir, 2012); thus, their outcomes discovered accuracies of the influence of how financial growth and development increase the energy consumptions in Pakistan. Moreover, they concluded that this might be accredited majorly due to the growth and development capacity, which boosts the useable features' overall requirements and the no services discovered processes. Hence, they concluded that there exist two-directional "Granger causality" by one and another. Some more researches also connecting the financial growth, economic development, CO2 emission, and energy consumption the studies include (Al-Mulali, Ozturk, & Lean, 2015; Bakhtyar, Kacemi, & Nawaz, 2017; Komal & Abbas, 2015; Salahuddin, Gow, & Ozturk, 2015; Ziaei, 2015) and including others. As per the prior studies in development and the empirical theories asserted by the innovative investigators, it is contrary for us to establish that there an increase in energy consumption with the countries effectively and efficiently usage of energy systems and financial growth and development will boost the increase in profitable processes of any country. Productive entrepreneurial activities will be grown and developed because of the prior study.

These current studies used CO2 emission as a proxy of pollution and defined its relationship with aggregate energy consumption, GDP, or economic growth. Recent studies in the review section show that most of the research was established on the Environmental Kuznets Curve, but numerous works do not inspect the existence of the EKC hypothesis. The existing research found a contradiction with their estimated results even they use the same economies and regions by examining the identical confirmation of the EKC hypothesis. In an instance of Turkey EKC hypothesis effect positively, (Seker, Ertugrul, & Cetin, 2015) and (Yavuz, 2014) give the support for Environmental Kuznets Curve validity; but at the same time, for the confirmation of EKC, there is no support for the same country in other studies (Halicioglu, 2009; Ozturk & Acaravci, 2010). Moreover, numerous current researches use trade openness in the first group as a supplementary indicator but debated results. The most precious Atici (2009) found that the trade coefficient is statistically insignificant (Jalil & Feridun, 2011) and (Nasir & Rehman, 2011) explain that an increase in pollution is due to trade openness (Dogan & Turkekul, 2016) specify that pollution is alleviated due to trade. In the first group in all studies, different countries and regions reported differently in explaining aggregate energy consumption to CO2 emissions. However, Granger causality is reported from different directions between energy consumption, carbon emission trade, and real income.

Furthermore, some studies added capital and labor, which is explained among the rest of the paper, exploring the relationship between economic development and renewable and non-renewable energy (Dogan, 2015). On the other hand, other groups faster aggregate energy use into energy consumption for several countries and regions, affecting GDP and economic development differently on renewable energy and non-renewable energy. Uni-directional causality exists between renewable energy and economic development (Kula,

2014) and (Dogan, 2015), while (Shahbaz, Loganathan, Zeshan, & Zaman, 2015) and (Inglesi-Lotz, 2016) disclosed the bidirectional causality between these variable

The next part, which is the third and last group, perhaps inspired by the second group associated with the GDP CO2 productions and energy by causes as renewable and non-renewable energy. In the last group, there are fewer and smaller studies as compare to the first group. The presence of the Environmental Kuznets Curve (EKC) theory examines in-between some portions of the 3rd group as in the first group (Al-Mulali, Saboori, & Ozturk, 2015). The obtained studies proved that CO2 emissions mitigate by renewable energy except (Apergis, Payne, Menyah, & Wolde-Rufael, 2010) and (Bölük & Mert, 2014). The net effect of trade openness is also used to deal with the omitted variables but conclude different trade effects on carbon emission. While according to the other side, defined a statistically insignificant result of trade openness, although (Al-Mulali, Ozturk, et al., 2015) and (Bakhtyar et al., 2017; Jebli et al., 2016) show that level of emissions decreases as trade rises. Simultaneously, literature in the 3rd cluster has opposite causality guidelines among trade, gross income, non-renewable and renewable energy, and CO2 emissions.

3. Data and Methodology

The present research is based on the selected[1] ASEAN group. It aims to examine the consequence of trade liberalization, renew-able energy, and non-renewable energy in the presence of GDP and square of GDP on CO_2 productions for the panel of ASEAN economies EKC framework. According to the EKC, adding the reference (Bölük & Mert, 2014), calculates CO2 emissions increases due to non-renewable energy usage. In this study, we used the first-generation panel unit root test before moving towards cointegration. After checking the order of integration by Lm Pesaran, Fisher, and PP, they then move to the cointegration level. Estimating the cointegration used the famous panel ARDL methodology, measured by pooled mean group (PMG) and mean group (MG).

The EKC model assumes that in the initial phases of the individuals' economic expansions rises the pollution; however, the rise in income primes to environmental betterment (Grossman & Krueger, 1991). According to the Environmental Kuznets curve (EKC) postulate, it is expected that the association between environmental pollution and economic development is quadratic. Moreover (Stern, 2004); similarly suggests that carbon elasticity concerning real income is similar in all countries, while CO2 emissions may differ amongst economies at a given level of gross income. These studies studied the relation between environmental and energy progress in the basic framework of the EKC in which emission levels decrease in GDP, REC (renewable energies), NREC (non-renewable energies), and the square of GDP (Bölük & Mert, 2014; Farhani & Shahbaz, 2014). For a panel study, you can write:

$$CO2_{it} = \gamma_{o,it} + \gamma_1 GDP_{it} + \gamma_2 GDP_{it}^2 + \gamma_3 REC_{it} + \gamma_4 NREC_{it} + \epsilon_{it} \quad (1)$$

Additionally, gross income and energy use from sources (Dogan & Turkekul, 2016; Halicioglu, 2009) highlight CO2 emissions' determination due to trade openness (TR). In the basic frame adding the trade openness as an extra variable, the following equation (2) explains the adjusted EKC model used in the present study:

$$CO2_{it} = \gamma_{o,it} + \gamma_1 GDP_{it} + \gamma_2 GDP_{it}^2 + \gamma_3 REC_{it} + \gamma_4 NREC_{it} + +\gamma_5 TARDE_{it}\epsilon_{it} \quad (2)$$

[1] Selection of the countries is based on the availability of the data.

Where i stand for cross-section, t stands for time periods and parameter γ_3 stands for coefficients of variables. Electricity production from non-renewable energy (NREC) is measured by fossil fuel energy use (% of total). Trade openness is dignified as a total trade ratio in GDP. CO2 (carbon dioxide emissions) is a proxy of environmental pollution measured as metric tons. GDP is measured as a value of GDP per capita growth (annual %); REC is electricity produced from renewable and measured by renew-able energy consumption percentage of total energy usage. Data were taken from WDI from the period of 1990 to 2018.

3.1. Unit root test

The unit root explains that the series is not stationary, which means that they have a time trend and some shocks because explained factors in the analysis cannot precisely measure the characteristic features, and the findings will be incorrect and cannot be reliable. Then the series become stationary, so we use it for analysis. There are numerous panel unit root tests such as PP - Fisher Chi-square, Fisher Chi-square, Pesaran and Shin W-stat ADF, Im and Levin, Lin, and the Chu. If the variables are in a mixed order of integration, then we applied the Pooled Mean Group (PMG) and the Mean group (MG) and which is called the panel Auto Regressive Distributive Lag (ARDL) technique.

3.2. Mean Group

We use pooled mean group and mean group estimations that follow the ARDL autoregressive distributive lag technique in the long run and short-run coefficients to estimates from the panel data. The mean group model (MG) is derived from (Pesaran, Shin, & Smith, 1999) by default. The problem of heterogeneity in the dynamic problem is solved by estimating MG, and another advantage is that the estimator MG provides a long-term coefficient for the panel. Estimate the long-term parameters by averaging the long-term parameters estimated through the ARDL models for the individual countries. The ARDL model follows these guidelines:

$$Y_{it} = \alpha_{it} + \gamma_i Y_{i,t-1} + \beta_i X_{it} + \varepsilon_{it} \quad (3)$$

In the above equation, i stand for the cross-sections, which are several countries, and t stands for the number of observations, t = 1,2, 3,….., N.

3.3. Pooled Mean Group

For panel analysis, the most appropriate technique used dynamically is ARDL (p, q) with error correction mechanism and, therefore, the estimate of the average group (MG) which is characterized (Pesaran & Smith, 1995) and the PMG (panel medium group) is established in (Pesaran et al., 1999), its form of representation is shown below.

$$Y_{it} = \sum_{j=1}^{p-1} \gamma_i (Y_i)_{t-j} + \sum_{j=0}^{q-1} \sigma_i (X_i)_{t-j} + \phi_i (Y_i)_{t-1} + \mu_i + \varepsilon_{it} \quad (4)$$

In the previous equation $X_{i,t-j}$ represents the range of the matrix (kx1), which is derived from the i group representing the sum of cross-sections and μ_i represents the fixed effect of the estimation of the data of the panel. If the panel data is not balanced, p & q may vary by country/cross-section. Under the conditions of homogeneity and connection of the long run between the explained and explanatory variables, PMG offers the best consistent estimates instead of the MG estimates (Pesaran et al., 1999).

So, according to PMG, our desired model will become like this:

$$CO2_{it} = \gamma_o + \sum_{i=1}^{p} \gamma_1 \Delta CO2_{i,t-1} + \sum_{i=0}^{p} \gamma_2 \Delta GDP_{i,t-1} + \sum_{i=0}^{p} \gamma_3 \Delta GDP_{i,t-1}^2 + \sum_{i=0}^{p} \gamma_4 \Delta NREC_{i,t-1} + \sum_{i=0}^{p} \gamma_5 \Delta REC_{i,t-1} + \sum_{i=0}^{p} \gamma_6 \Delta TRADE_{i,t-1} + \gamma_7 CO2_{i,t-1} + \gamma_8 GDP_{i,t-1} + \gamma_9 GDP_{i,t-1}^2 + \gamma_9 NREC_{i,t-1} + \gamma_{10} REC_{i,t-1} + \gamma_{11} TRADE_{i,t-1} + \epsilon_{it} \quad (5)$$

3.4. Data Sources

For 9 ASEAN[2] economies, the annual time series data for the time span of 1990 to 2018 has been used from the World Development Indicators (World Bank, 2020).

4. Results and Discussion

Summary statistics of variables are given in table 2,

Table 2
Description Summary of variables

Variables	Mean	Maximum	Minimum	Std. Dev.	Observations
CO2	4.935	33.965	0.100	6.540	261
GDP	1.409	12.788	-210.671	19.848	261
NREC	66.720	100.000	13.813	27.776	261
REC	34.686	91.119	0.000	29.333	261
TRADE	124.399	437.327	0.167	95.581	261

According to table 2, carbon dioxide is measured by Co2 emission in (mt), with the mean value is 4.95. The maximum and minimum value is 33.965, and 0.100 metric ton with the standard deviation is 6.540, growth rate per capita, non-renewable energy is proxied by fossil fuel energy use, renewable energy use is measured by renewable energy consumption, and finally, trade (which is imports plus exports % of GDP) mean value is 1.40, 66.720, 34.686 and 124.399. Their standard deviation is 19.848, 27.776, 29.33, and 95.581. First of all, we move towards the unit root investigation and applied all unit root tests, and outcomes can show in table 3.

Table 3
Unit root results

Tests	Levin, Lin & Chu		Im, Pesaran, and Shin		ADF - Fisher Chi-square		PP - Fisher Chi-square	
Variables	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
CO2	3.887	1.000	3.353	1.000	9.059	0.958	9.608	0.944
DCO2	-5.797	0.000	-5.349	0.000	62.898	0.000	195.020	0.000
GDP	-4.299	0.000	-6.299	0.000	71.365	0.000	105.564	0.000
NREC	1.409	0.921	-1.743	0.041	43.938	0.001	284.342	0.000
DNERC	-6.887	0.000						
REC	-3.396	0.000	-2.410	0.008	62.568	0.000	81.420	0.000
TRADE	-0.962	0.168	0.595	0.724	16.209	0.578	32.182	0.021
DTRADE	-7.216	0.000	-8.257	0.000	94.158	0.000	749.381	0.000

[2] Brunei Darussalam, Vietnam, Thailand, Cambodia, Malaysia, Indonesia, Myanmar, Singapore, Philippines.

According to table 3, the above table shows the unit root tests indicate that, such as Fisher and PP Lm Pesaran, Shin W-stat, and Levin Lin Chu. All of them show that CO2 and trade are non-stationary, and the first difference became stationary, and GDP and Renewable energy consumption are stationary at level. However, Levin Lin and the Chu show NREC is non-stationary at level and stationery at the first difference, it is stationary at the first difference, but others show that it is stationary. Overall conclude that the order of integration is mixed, so we used the panel ARDL methodology, and the outcomes of the panel ARDL model are shown in table 4.

Table 4
ARDL short-run results

Variable	Coeff.	SE	t-Stats	Prob.
ECM(-1)	-0.088*	0.046	-1.910	0.058
C	-2.174**	1.087	-1.999	0.048
D (CO2(-1))	0.147	0.116	1.261	0.210
D (GDP)	-0.037	0.046	-0.808	0.421
D (GDP(-1))	0.098	0.113	0.866	0.388
D (GDP^2)	0.015	0.011	1.347	0.180
D (GDP(-1)^2)	0.031	0.026	1.201	0.232
D (NREC)	22.641	22.675	0.998	0.320
D(NREC(-1))	0.248	0.365	0.678	0.499
D(REC)	4.144	4.415	0.939	0.350
D(REC(-1))	0.308	0.531	0.579	0.563
D(TRADE)	-0.029	0.025	-1.146	0.254
D(TRADE(-1))	-0.006	0.008	-0.719	0.473

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

According to table 4, the error correction term shows that the model moved to the in-equilibrium condition. Then it will move to equilibrium with a speed of 0.088% annually. Then the speed of adjustment will be almost 9 percent annually. In short-run, carbon dioxide emissions are not affecting by all the variables, and the long-run association supports the existence in the model, which further explains that the exogenous variables will affect the dependent variable in the long term. In table 5, the long run results are explained.

Table 5
ARDL long run results

Variables	Coeff.	SE	t-Statistic	Prob.
GDP	0.134**	0.049	2.714	0.008
GDP^2	-0.036**	0.010	-3.517	0.001
NREC	0.354**	0.122	2.912	0.004
REC	0.242**	0.089	2.734	0.007
TRADE	-0.013**	0.004	-2.924	0.004

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

According to table 5, the study's findings show that all variables significantly affect the carbon dioxide emission in ASEAN economies. GDP, NREC, and REC have a +ve impact on CO2 emission, while the GDP square and trade negatively affect CO2 emissions. Initially, GDP boosts the carbon release level by 0.134%, and after achieving it at a certain point, it will decrease the carbon production by 0.03% in ASEAN countries. While renewable and non-renewable energy boosts the environmental degradation level by 0.354% and 0.242, respectively. And trade help in the level of environment clean and healthy by 0.013%. It should be mentioned that the estimations of the declared coefficients concerning t statistics and p values are all statistically significant.

CO2 emission is positively affecting GDP, whereas the GDP square hurts CO2 emissions, so the influence is positive on carbon emissions by real income for members with low returns. However, it is eventually converting negatively and decreases as the ASEAN economies transfer to higher-income groups. Besides this conclusion, EKC's assumption is reliable in ASEAN economies because the emission elasticities of CO2 concerning real quadratic income and real income are negative and positive. In general, ASEAN economies rise in GDP growth leads to the betterment of the environment. The EKC framework is reliable in numerous studies, including (Bölük & Mert, 2014; Farhani & Shahbaz, 2014).

Non-renewable and renewable energies have an optimistic effect on carbon emissions in ASEAN countries. It also explains why renewable energy use subsidizes in improving the environment as it agreed with opinion from state of the art, renewable energies reduce carbon emission levels. As there is more use of renewable energy in economies, they release less CO2. The result of this research is stable as in (Al-Mulali, Ozturk, et al., 2015; Bakhtyar et al., 2017; López-Menéndez, Pérez, & Moreno, 2014; Shafiei & Salim, 2014). On the other hand, it contrasts with that of (Bölük & Mert, 2014).

Regarding the consumption of NREC, non-renewable energy causes significant degradation of the environment. The emissions elasticity of CO2 linked to non-renewable energies suggests that a rise of 1% in NREC raises the emission level by 0.35%. In reality, the negative effect of fossil fuel use on the environment is a common consensus. The influences of energy through a source conclude that the increase in renewable energy in the mixture of energy attenuates CO2 discharges. In contrast, the increase in the non-renewable factors in mixed energy contributes to environmental degradation in ASEAN countries.

Recently trade liberalization has presented a good overview of environmental progress aimed at numerous regions besides countries (Dogan & Turkekul, 2016; Jebli et al., 2016). According to the literature, the current study also reveals that increasing trade openness mitigates ASEAN economies' carbon emissions. More specifically, in the long run, using a high significance level, a 1% rise in trade openness mitigates the emission level by 0.01%. As noted in the introductory segment, environmental effects have three types of trade. The findings revealed that the net impression of the environment, trade decreases the environment's degradation since the technique effect and the effect of structure control the scale effect. It creates logic because developed economies, particularly in recent decades, prepared good improvement in discovering new technologies, and the ASEAN panel appears to the advantage of the diffusion of technology over trade. By focusing more on the effect of composition, we can draw some new deductions; For example, it appears that dirty industries and energy-intensive operating in ASEAN regions favor transferring to develop and underdeveloped nations as they consider less standard of the environment as compare to ASEAN nations. The latter case mainly refers to the pollution paradise hypothesis. Developed countries made aware by the public of environmental pollution cause the relocation of dirty factories and their operation in countries where environmental regulations and observances are less strict (Cole, 2004). In conclusion, ASEAN probably exports and produces energy-efficient and environmentally responsive imports and dirty goods. While it appears that place to place pollution changes and that the general level of greenhouse gasses remains unaffected, it is the reality that ASEAN benefits from freer trade and weak environmental standards.

5. Conclusion

Although several studies explored environmental degradation factors, the existing literature faces criticism due to the data selection. Most researchers used the overall energy

consumed in the economy, and the second criticism is panel technique selection. Almost all previous studies ignore the cross dependence of panel methods. Forecast errors occur due to not taking account of the cross-section dependency. The study's objective was to inspect real income effects, renewable and non-renewable, the square of gross income, and trade to the carbon emission levels in the EKC framework for ASEAN from 1990 to 2018 using the ARDL techniques panel. The outcomes of this study can be concise as shadows. The term error-correction specifies that trade, GDP, CO2 emissions, GDP2, renewable, and non-renewable energy will co-integrate, therefore taking a long-term affiliation. The ASEAN states their existence of the EKC hypothesis Because the impact of GDP and GDP square has negative and positive, respectively, which confirms EKC theory's presence there.

Concerning the policy suggestions and recommendations, ASEAN should continue to reduce the amount of non-renewable and upsurge the quantity of renewable energy and energy for lesser carbon emissions. Meanwhile, the decline in non-renewable energy does not subtract from real ASEAN incomes; policies can be implemented to reduce the amount of non-renewable energy-deprived of damaging GDP. Since states can yield energy at a lesser cost from non-renewable sources than renew-able energy, ASEAN regions must sustenance researchers besides universities as energy creation from renewable sources is cheaper relatively. Consequently, the execution of enormous renewable energy in the mix energy for each region member can also be economically sustainable. Policymakers must take more emphasis on raising public responsiveness to renew-able energy and unpolluted environment. ASEAN must remain to specify in the making of energy-efficient and soft environment-friendly goods and force companies of dull industries to comply with strict environmental procedures to settle in less environmentally friendly countries. For future research, the researchers modified this econometric model for the individual's use and production of energy and examined their impact on environmental degradation level for developing and developed countries. Because in the environmental degradation has a different scenario in both the developed and developing countries. Furthermore, they performed the analysis based on income-wise regions.

Conflict of Interests/Disclosures

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