https://doi.org/10.52131/jee.2021.0202.0019

*i*RASD Journal of Energy & Environment

Volume 2, Number 2, 2021, Pages 78 - 89

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

Impact of Renewable Energy Consumption and Health Expenditure on Air Pollutants: Implications for Sustainable Development in ASEAN Countries

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ARTICLE INFO

Article History:
Received: November 24, 2021
Revised: December 17, 2021
Accepted: December 30, 2021
Available Online: December 31, 2021

Keywords:
Carbon dioxide emissions
Renewable energy consumption
Health expenditures
Dynamic GMM
ASEAN countries

ABSTRACT

This study examined the association between economic development and environmental degradation in the presence of health expenditure and renewable energy for selected 6 ASEAN nations covering the period of 2000 to 2018. Before estimating the model, firstly check the stationary of variables for this purpose Levin Lin Chu unit root applied, results indicate that all variables are stationary at level. GMM is efficient in eliminating fixed/random effects in the model and overcoming the problem of endogeneity. For causal analysis, we used Granger causality test. The results indicate a bi-directional association between the consumption of energy and carbon emission. There exists a uni-directional association among Economic development, expenditure on health, and environmental degradation. GMM results indicate that spending on the health sector and the consumption of renewable energy sectors decline the environmental degradation level; on the other hand, economic growth boosts the ASEAN nations' carbon emission level. The study's recommendation is to increase the level of economic development by enhancing the energy sector from non-renewable energy to renewable energy. As it boosts the level of economic growth, which ultimately improves health development and technologies, which will strengthen the health facilities in the nation and reduce the level of carbon production that helps keep the environment healthy and clean.

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1. Introduction

According to World Health Organization (2015) almost 18% of global carbon emission CO2 is recognized as energy and fuel used by the domestic sector. The growth of greenhouse gas discharges stays a severe risk to human health and the atmosphere. It is anticipated that renewable energy production, like wind, biogas, solar, geothermal, etc., of cleaner technologies can significantly decrease climate change pollutants by approximately 0.4e0.9 billion tons from 2010 to 2020 of CO_2 emissions.

Further, it is observed that health care services play a significant role in fighting against environmental change. In developing countries, climate change represents 3% to 8% (World Health Organization, 2011). Energy reproduces at lower rates in ASEAN countries than in developed countries (USAID, 2009). Additionally, it has been estimated

that in developing countries between200.000 to 400.000 health clinics and hospitals have no power or have imperfect electrical supplies (World Health Organization, 2015). Renewable resources are abundant in ASEAN countries, whereas renewable technologies and investment projects are significantly needed for the development of their economies. Further, we can see in table 1 and figure 1 t the carbon emission and renewable energy consumption in ASEAN countries.

Table 1
Average of ASEAN countries of CO2 emissions and Renewable energy

Country Name	CO2 Emission	Renewable Energy
Cambodia	4977.663	70.82857
Indonesia	403432.9	39.64474
Malaysia	200969	5.151371
Philippines	89238.18	30.1104
Thailand	274905.2	21.57656
Vietnam	132790.4	41.20691

Table 1 shows the average value of 2000 to 2018 of the CO2 production and Renewable energy in ASEAN states. According to the table and figure 1, Indonesia has the highest carbon emission with the regular use of renewable energy in the selected ASEAN countries. While on the other hand, Cambodia has the highest use of renewable energy, with the lowest carbon dioxide emissions in ASEAN countries. Vietnam averagely emits carbon emission and use renewable energy from all ASEAN countries.

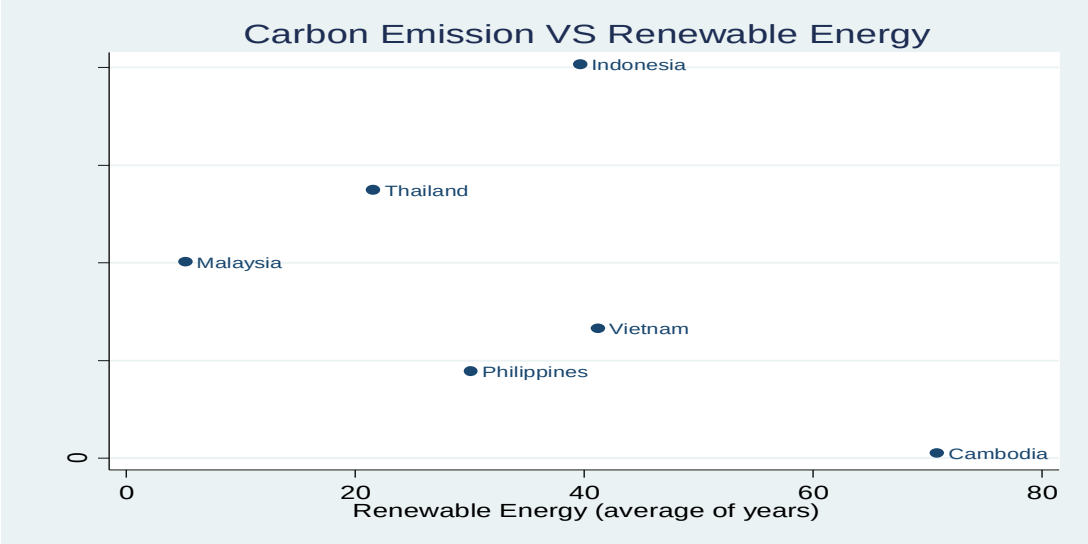

Figure 1: Carbon Emission VS Renewable Energy

In electricity, the installation of wind turbines and photovoltaic solar panels stand as an excellent indicator for provender health accommodations. Furthermore, it reduces carbon emissions which fight global warming, and motivates developing health excellence in emerging nations to inspire clean technologies. This paper studies the empirical connotation amongst the economic expansion and environmental level within health facilities and renewable energy factors for the ASEAN region. In the panel framework, health expenditures are used as a health indicator.

Further discussed the impact of environment, spending on health and renewable energy in ASEAN countries. We confidently describe that none of the experimental panel studies exist, defining the association and dynamically linking health indicators and renewable consumption. The present study fills this gap with this objective, mainly concentrating on the ASEAN region, which takes significant health indicators equaled to advanced countries. While having many renewable energy resources, it has unsatisfactory investments in renewable energy projects. The rest of the paper concludes that section 2 discussed the literature review after that, data and methodology explain in section 3, section 4 concludes the results and discussion, and part 5 provides the conclusion and policy recommendations.

2. Literature review

Previous studies analyzed the interdependence affiliation among the economic development and renewable energy usage (Apergis & Payne, 2010a, 2010b, 2011; Baloch et al., 2021; Chien et al., 2021; Fazal, Gillani, Amjad, & Haider, 2020) or between CO_2 productions and consumption of renewable energy (Apergis, Payne, Menyah, & Wolde-Rufael, 2010; Jebli, Youssef, & Apergis, 2015; Jebli, Youssef, & Ozturk, 2016; Jianjun et al., 2021; Li et al., 2021; Menyah & Wolde-Rufael, 2010; Mohsin, Kamran, Nawaz, Hussain, & Dahri, 2021). But the present research is associated with the work dealing with economic expansion, CO_2 emanations, and renewable energy consumption, which deals with pollutant emission and health facilities. These earlier researches confirm the presence of causality among carbon emissions and usage of renewable energy resources, output, and Granger causality determined by the used econometric technique. However, previous studies conclude that economic expansion and renewable energy use have causality and increase renewable energy consumption on the environment and economic growth.

In a recent study, there are other determinants like trade and tourism. The most significant influence in pollution emanation is the trade that justifies more concern. According to the Organization for Economic Co-operation and Development (OECD), Jebli et al. (2016) explain that carbon emission decreases as renewable energy consumption or trade increases. It recommends increasing renewable energy consumption or trade effects policies to fight against global warming in these countries. A panel of OECD countries describes the positive impact of trade on GDP per capita using a reversed U-shaped environmental Kuznets curve (EKC). Some other studies explained that tourism is an essential factor for ecological conditions.

Jebli et al. (2015) explained the Tunisia condition by proving a dynamic causal relationship between output, waste consumption, CO_2 releases, combustible renewables and international tourism. Their results indicate that the increase in carbon emission is due to waste use, international tourism, and combustible renewables. Their finding defines that transforming wastes into energy, energy for transport, heating, cooling, and rise in food consumption makes CO_2 emissions. Sub-Saharan Africa also has an interest in renewable energy. Ben Jebli, Ben Youssef, and Ozturk (2015) observed the effect of renewable energy on energy emission adjustment. This study uses a panel of 24 sub-Saharan African economies using the cointegration method. They recommend that using trade exchange technology transfers decreases carbon emissions level and renewable energy. Furthermore, using 51 sub-Saharan African nations Bakhtyar, Kacemi, and Nawaz (2017) provides the long-run dynamic link between the use of biomass energy and GDP development. Their suggestion indicates the positive influence of the method of biomass on GDP development.

Jaunky (2011) inspected the association between carbon emissions and income from 1980–2005 by employing VECM and GMM techniques in 36 high-income nations. This study authorizes EKC in various economies, comprising Portugal, UK, Oman, and Greece. By opposing the given research, Saboori and Sulaiman (2013) inspected the association between economic growths, disaggregated and aggregated energy use, and carbon releases from 1980 to 2009 in Malaysia. Furthermore, he investigated that EKC is confirmed by employing different energy indicators. Though, not at all indication was established for EKC among economic development and per capita carbon dioxide discharges by employing different energy sources.

Similarly, Furuoka (2015) reexamined the economic development and carbon emission relationship in the presence of the EKC theory and established that there is no sign of EKC among per capita carbon discharges and economic development. In current years, numerous researches are dedicated to the EKC (Environmental Kuznets curve) framework by the impact of monetary expansion by applying different econometrics methodologies like panel and time series. For example, Javid and Sharif (2016); M. A. Nawaz, M. A. Azam, and M. A. Bhatti (2019) observed monetary expansion, financial development, energy use, and GDP square on CO2 emissions between 1972 and 2013 Pakistan using the ARDL approach. The study's result establishes that a rise in economic development, financial expansion, and energy consumption increases CO2 emissions.

Afterward, the beginning stage lessens carbon emissions, and a test of the EKC framework is valid. Related effects are found Solarin, Al-Mulali, Musah, and Ozturk (2017) in Ghana from 1980 to 2012, by adding urbanization between CO2 emission function, that also caused i growing carbon productions.

Shahbaz, Tiwari, and Nasir (2013) inspected the impact of economic development and financial growth on carbon emanations using the ECM and ARDL method between 1965–2008 in South Africa. Economic development increases carbon productions, whereas financial expansion decreases it. Furthermore, they developed an indication of EKC in their research. Dogan and Seker (2016) examined affiliation between carbon emissions, financial development, energy use, and gross income over the time period 1975–2011 in OECD countries by employing various panel econometric methods that establish EKC in these nations.

Ozturk and Acaravci (2013) establish a significant association between carbon emissions and financial expansion for 1960–2007 in Turkey, but EKC is confirmed. Besides this, Farhani and Ozturk (2015) discovered the causation association among energy consumption, financial growth, carbon productions, and urbanization in the existence of the EKC framework in Tunisia from the time of 1971– 2012 by using the ECM approach and ARDL bounds testing approach and establish no sign for the EKC validity. Additionally, all indicators directly associate CO2 (carbon dioxide) productions.

There is a lack of explaining the relationship between health indicators and other variables like carbon emissions and economic growth in previous studies. Jerrett, Eyles, Dufournaud, and Birch (2003) examined the link between environmental factors and expenditures on health maintenance by using a panel of 49 countries of Ontario. The study's finding defined that environmental investments and total toxic pollution have an increasing and significant effect on health expenses. Additionally, these authors recommend that countries that faced higher per capita expenditures on health experienced a high level of pollution emissions. At the same time, those economies that spend more on an environmental quality show low health maintenance expenditures. Lu et al. (2017) examined the dynamic link between financial development, environmental conditions, and health expenditures in China. They used a panel of 30 provinces of china from the time of 2002 to 2014. Their finding indicates that environmental pollution hurts public health. However, medical performance and educational activities have significant participation in public health and economic development. The research obtained uni-directional causality among these variables while (Nawaz, Ahmad, Hussain, & Bhatti, 2020; M. A. Nawaz, A. Azam, & M. A. Bhatti, 2019; Shahbaz, Loganathan, Zeshan, & Zaman, 2015; Shair et al., 2021) and (Inglesi-Lotz, 2016) disclosed bidirectional causality links between them.

Numerous studies explained the affiliation between environmental degradation and economic expansion using a reversed U-shaped Environmental Kuznets curve (EKC). In the initial stage of economic expansion, development causes environmental degradation (Grossman and Krueger). After a beginning level of development, environs improve due to industrial activity, which promotes ecological awareness (Baltagi, Fomby, & Hill, 2000).

Usually, researchers pay less attention to the relationship between CO_2 discharges and health expenses and the relationship between economic development and health expenses and economic expansion and CO_2 emanations. Chaabouni and Zghidi also explain the association among health expenditure, CO2 production, and economic development by using a dynamic simultaneous equation model, a panel of 51 economies from the time period of 1995-2013(World Health Organization, 2015).

The research also uses these models in comparative analysis for three groups—low income, lower middle income, and upper-middle-income cluster nations. The study's finding proved the bidirectional causality affiliation among economic development, CO2 emissions, economic expansion, and health expenditure, except in low-income economies, CO2 emissions to health expenditures are uni-directional. Previous studies focus on the cause and result of health expenditure and CO2 emissions.(Bilgili & Ozturk, 2015; Erdil & Yetkiner, 2009; Hasanov & Mikayilov, 2017; Jalil & Mahmud, 2009; Kao & Chiang, 1999; Mark & Sul, 2003; Pedroni, 2001, 2004; Sun et al., 2021; Xiang et al., 2021). These studies are

attentive to the bidirectional causality association between health expenses and CO_2 production.

Ghorashi and Rad (2017) explain the causal connection among economic growth, health expenses, and CO2 emissions by using the simultaneous model for Iran from 1972-2012. The study's finding explains the bidirectional relationship of causality between economic development and CO_2 releases. It is also shown that health expenditure on economic growth has a uni-directional link. In the case of Iran, this positive relationship explains a vital role in environmental quality. It is recommended that environmental protection and technology transfers must improve to decrease environmental damage.

3. Methodology

According to literature which expressed strong relationships between health and environment. As Lu et al. (2017) explained, a low carbon discharge level leads to a good and healthy environment; ultimately, it positively influences people's health. He also found that environmental degradation has the worst impact on people's health. The carbon production level would be decreased by increasing healthcare projects' expenditure as part of the GDP. That is because of consideration of those sectors which produce less amount of carbon emission and create less pollution (like renewable energy projects) as compared to another sector of countries which produce a massive quantity of CO2 (like non-renewable energy projects which is the use of fossil fuel) and destroy the environment. So, the study's primary concern is to estimate the EKC theory for ASEAN nations with healthcare costs. For this purpose, we used the health expenditure with economic development and renewable energy consumption on carbon emission. Health care projects are the mainstream indicators for environmental degradation. Hence the theoretical model will become;

CO2=f (GDPCG, REC, HE, POP) (1)

The econometrics equation will become like this

$$CO2_{it} = \alpha_o + \alpha_1 HE_{it} + \alpha_2 REC_{it} + \alpha_3 GDPPCG_{it} + \alpha_4 POP_{it} + \epsilon_{it} \quad (2)$$

Where the environment is measured by the emissions of carbon dioxide, which is a dependent variable represented by CO2, and the independent variables are Healthcare expenditures per capita (HE), it is used as a proxied for the health condition, and controlled indicators include the consumption of renewable energy per capita (REC), economic expansion is measured by the growth of per capita GDP (GDPPCG) and human development is regulated by the population growth rate (POP) and represents the indecency of the cross-sections ϵ_{it} designate the time span in the study.

Before moving towards the empirical examination of environmental degradation and the health status and use of renewable energy. First of all, check the variables' statistics because we have the panel data, and it has both the characteristics of time-sequential and cross-section. So, it's necessary to check the cross-section dependence and variables stationarity. According to the aspects of the data, first of all, check the order of integrating the data. That's why to use the Levin Lin Chu (LLC) panel unit root test to confirm the data's current condition. LLC test designates that the data has a unit root at a level and first diff, stationary.

3.1. Panel Unit Root Tests

There is some panel unit root that, but, in this study, we "Levin, Lin, and Chu" LLC test to check the order of indicators of the data. This is a severe problem of the time trend data because if the data has the unit root, the results are biased, and regression results are spurious. To avoid the spurious regression problem and wanted unbiased results, it's necessary to check the order of integration of the series and then select the appropriate econometrics methodology.

3.1.1. Levin, Lin, and the Chu

According to the unit root test Levin, Lin, and Chu (LLC), the standard unit root was assumed to verify the series's unit root. Levin's test also followed Dickey-Fuller's specification, and the equation is written below.

$$\Delta Y_{it} = \alpha Y_{i,t-1} + \sum_{j=1}^{pi} \beta_{i,j} \Delta y_{i,t-j} + X'_{it}\delta + \varepsilon_{it} \quad (3)$$

In the above equation Y_{it} is the differenced term of the dependent variable in the panel data, $\alpha = \rho - 1$, which represents the unit root, p is the lag operator for Y_{it}which shows the increase and decrease in the number of cross-sections. And X' is the explanatory variable in the model. Finally, it is assumed that t-stats are normally distributed frequency.

3.2. Econometrics Estimation

After verifying the order of integration of series, the next important aspect is endogeneity. This study has panel data that might have the problem of endogeneity, which creates biased results. This study uses the dynamic panel GMM econometric model to overcome that severe econometric issue. Because it efficiently minimizes both the time trend and endogeneity issue. Dynamic GMM quickly faces the challenge of endogeneity that has been tested with the autocorrelation test and verifies the validity of the tool used to deal with the problem of endogeneity.

3.2.1 Generalized Method of Moment (GMM)

Panel data consists of time series and cross-sections, so there might be endogeneity; instrumental variables minimize the endogeneity issue. According to equation three, our proposed model is as follow

$$CO2_{it} = \alpha_o + \alpha_1 CO2_{it,j} + \alpha_2 HE_{it} + \alpha_3 RE_{it} + \alpha_4 GDPCG_{it} + \alpha_5 POP_{it} + \mu_{it} \quad (4)$$

According to the equation, CO2 emissions are the dependent variable, and independent variables are lag of CO2 Emission, per capita health expenditure, renewable-energy consumption, per capita GDP development, and population growth. Where i denote the cross-section, and t represents the time.

3.3. Data Sources

Annual panel data of 6 ASEAN[1] countries from 2000 to 2018 has been taken from the World Development Indicators (World Bank, 2020).

4. Results

Descriptive statistics of the data is expressed in table 2;

Table 2
Summary Statistics

Indicators		Mean	Stdev	Mini	Maxi
	Overall	0.41811	1.07559	-1.8164	2.09559
CO2	between	1.14821	-1.3556	1.92311	
	within	0.21419	-0.1837	0.94741	
	overall	34.7531	20.8325	3.81904	83.0198
REC	between	22.0837	5.15137	70.8286	
	within	4.89778	19.5959	51.5099	
	overall	2.28863	3.70232	-0.03	16.6482
HE	between	3.26502	0.10742	8.75925	
	within	2.17828	-6.0315	10.1776	
	overall	4.26376	2.11009	-3.2856	11.4849
GDP	between	1.15711	3.28378	6.03039	
	within	1.82397	-3.1696	9.71828	

[1] Cambodia, Indonesia, Malaysia, Philippines, Thailand and Vietnam.

Table 2; the summary statistics of the data include the mean, standard deviation, maximum and minimum value of the data. That helps to understand the current situation of the data from which we conclude the data distribution.

The overall mean value of CO2 emissions is 0.41, with a standard deviation of 1.07, and a minimum value of -1.81. The maximum amount is 2.09, and in between, the country's mean value is 1.14, and within is 0.21, so the overall mean value is less. While the mean value of REC is 34.75, HE is 2.28, GDP is 4.26, and the standard deviation value is 20.83, 3.70, and 2.11. Hence, the overall variation in the data is less, which is quite helpful for estimation.

Table 3
Panel unit root test (Levin-Lin-Chu)

	Level		First Diff.	
Variables	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
CO2	-3.177	0.001		
REC	-2.539	0.006		
GDPCG	-3.393	0.000		
Pop	-1.460	0.072		
HE	-6.361	0.000		

The Levin Lin Chu unit root test verifies that all variables have zero-order integration. This means that all indicators are stationary at level. Hence, firstly, we check the causal relationship among the variables for either a uni-directional affiliation among the variables or a bidirectional relationship between them. Further, we can use the GMM econometrics model to estimate the model. And the estimates of GMM are given in table 5;

Table 4
Granger Causality test

Null Hypothesis:	**W-Stat.**	**Z-bar-Stat.**	**Prob. Value**
GDPCG doesn't homogeneously cause ICO2MT	4.14756	1.4563	0.1453
ICO2MT doesn't homogeneously cause GDPCG	2.27167	-0.10694	0.9148
IHEPC doesn't homogeneously cause ICO2MT	4.18221	1.48518	0.1375
ICO2MT doesn't homogeneously cause IHEPC	7.86919	4.55766	5.00E-06
IREC doesn't homogeneously cause ICO2MT	2.03669	-0.30275	0.7621
ICO2MT doesn't homogeneously cause IREC	6.92854	3.77378	0.0002
IHEPC doesn't homogeneously cause GDPCG	1.82282	-0.48098	0.6305
GDPCG doesn't homogeneously cause IHEPC	3.39692	0.83077	0.4061
IREC doesn't homogeneously cause GDPCG	3.8882	1.24017	0.2149
GDPCG doesn't homogeneously cause IREC	2.20443	-0.16297	0.8705
IREC doesn't homogeneously cause IHEPC	3.24068	0.70057	0.4836
IHEPC doesn't homogeneously cause IREC	6.20478	3.17065	0.0015

According to table 4, we accept the null hypothesis in most cases. All variables do not Granger cause each other except carbon emission generates renewable energy, and health expenditure causes the renewable energy in the six selected ASEAN countries.

Granger-causality outcomes designate a short-run casual association between renewable-energy consumption and the emanation of carbon dioxide. That further confirms that a rise in renewable energy consumption significantly affects the short-run environmental degradation level. The results are also verified by (Apergis et al., 2010). They found a significant effect of renewable energy on the production level of CO2 in 19 developed and developing nations. But this finding contradicts (Menyah & Wolde-Rufael, 2010), who found that there is no significant association between renewable energy and the environment for the United States (USA). Most literature confirms the inverse relationship between renewable energy and carbon release level in the long run, which means that a rise in the level of renewable-energy minimize the production of CO2 level.

According to the conventional hypothesis, which expressed the bidirectional association among the economic expansion and use of renewable energy and results achieved, the uni-directional affiliation exists. Furthermore, according to the literature, there is only a uni-directional association between economic development and health development in the short term. The outcomes of grange causality also verified a uni-

directional association between economic growth and health, and no relationship exists between health development and economic development. That further explains that a rise in economic expansion immediately boosts health care expenditure. So, these countries are not spending on health care due to some constraints, such as income/budget constraints. The above results are similar to (Erdil & Yetkiner, 2009). Similar results are also found in the case of low and middle-income nations. Furthermore, these results contradict (Amiri & Ventelou, 2012) because they concluded in OECD economies that there is bi-directional causality among the expenditure on health and economic development.

Table 5
Estimates of GMM for ASEAN Countries

Dependent Variable: CO2 Emission				
Variables	**Coef.**	**Stdev**	**t-stats**	**Prob.**
L1. CO2	0.924***	0.046	20.220	0.000
REC	-0.018**	0.008	-2.180	0.032
HE	-0.043*	0.023	-1.820	0.072
GDP	0.029**	0.013	2.200	0.030
Model Diagnostics				
AR1				0.001
AR2				0.962
Sargan				0.065
Difference-in-Sargan				0.992

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

Results of GMM estimates show that the usage of renewable energy and expenditure on health diminish carbon emissions. At the same time, economic development boosts the level of carbon emission in ASEAN nations.

Results explained that renewable energy consumption helps keep the environment healthy and clean by reducing the level of carbon emanation in ASEAN countries. Furthermore, it verifies that REC has an inverse effect on CO2, which also means that if the nation moves towards REC sources. It has some significant advantages, like reducing fossil fuel, a type of non-renewable energy that minimizes the environmental pollution level. The environment becomes neat and healthy due to the safe money from the health care project and spending the money to improve the health conditions. And the second most important REC helps to total energy level and boosts economic development without affecting the environment level. So, these nations should inspire to adopt new renewable-energy projects like solar, wind, and geothermal in the health department for energy production, heating, and cooling systems (Apergis et al., 2010).

Results indicate that expenditures on health have an increased effect on the level of CO2. It shows that if the country has low budget resources and cannot spend more on health budgets, they face a terrible environment. And results are similar (Erdil & Yetkiner, 2009). And it also means that if the health conditions are right, which reduces the country's health expenditure, they should use savings to better the environment. And contradicts from Amiri and Ventelou (2012) they found a positive correlation among the health care and environment by a reduction in the level of CO2 emanation that results better the quality of environment and quality of air improved that caused a positive impact on the health condition and also confirmed by (Lu et al., 2017). Hence results conclude that a rise in health % of GDP minimized the carbon production level. Because of less emission of CO2 from the health departments compared to other sectors in the country. Due to the efficient use of energy like fossil or renewable energy.

Economic development has an increasing impression on the carbon discharge level. Results are consistent with the EKC hypothesis of the first stage because ASEAN nations are developing countries and hence are at the early stage of the EKC hypothesis. They do not reach the required level of growth. Next, they reduced carbon emissions and promoted a green and healthy environment. Findings are similar to those (Jebli & Youssef, 2015) and (Jalil & Mahmud, 2009).

According to the diagnosis of the model, AR, the Sargan test indicates that the model fits well because according to AR, which suggests that there is no autocorrelation problem, and the Sargan analysis shows that the list of instruments is effective.

5. Conclusion

This study inspects the observed association among economic development on the carbon emanation level in the existence of health expenditure and renewable energy consumption for selected 6 ASEAN nations from 2000 to 2018. Our empirical analysis includes the LLC unit root test, and a theoretical model is examined by dynamic panel GMM methodology.

Results of GMM estimates conclude that renewable energy and expenditure on health promotes a green and healthy environment by decreasing carbon production. And economic development boosts the carbon discharge level and makes the atmosphere unhealthy. There is some recommendation based on the estimates; 1) economic development is the primary determinant to fight global warming by increasing the expenditure on health and adopting renewable energy technologies that keep the environment clean and healthy. For example, according to the EKC hypothesis in ASEAN economies, it is expressed that it reduces CO2 discharge in the nation with continuous economic development. So, a rise in the level of economic expansion to a certain level is required, then it promotes the environment well within the presence of good health.

Secondly, it is suggested that adopting renewable energy technologies has a significant increasing impact on citizens' health and reduces the factors that create environmental degradation. And most of the ASEAN nations are rich in the level of renewable energy technologies. So their efficient use of those renewable energy resources can benefit from many sources like reducing fossil fuel consumption. From there, they save the money and spend it on the health department to promote health facilities, which improves the citizens' health condition.

Furthermore, renewable energy sources have an important impression on the environment and the nation's health. It reduces the carbon emission level and promotes the health facilities that improve the current health condition. For developing countries, renewable energy projects play a vital role because conventional energy sources are not available to those areas that are so far from the cities that are the use of those sources for health is impossible to use. Thus, renewable energy efficiently and available energy sources to overcome these issues in areas far from the cities, but that is not vital for those from lower developing regions due to income constraints and lack of infrastructure.

Future research is an excellent chance to identify the resources from where they can encourage renewable energy use in those lower-income developing nations that cannot afford to shift from nonerasable energy resources towards renewable energy resources. Indeed, they boost economic development and promote health facilities that enhance health quality and promote a healthy and clean environment.

References

Amiri, A., & Ventelou, B. (2012). Granger causality between total expenditure on health and GDP in OECD: Evidence from the Toda–Yamamoto approach. *Economics Letters, 116*(3), 541-544. doi:10.1016/j.econlet.2012.04.040

Apergis, N., & Payne, J. E. (2010a). Renewable energy consumption and economic growth: evidence from a panel of OECD countries. *Energy policy, 38*(1), 656-660. doi:10.1016/j.enpol.2009.09.002

Apergis, N., & Payne, J. E. (2010b). Renewable energy consumption and growth in Eurasia. *Energy Economics, 32*(6), 1392-1397. doi:10.1016/j.eneco.2010.06.001

Apergis, N., & Payne, J. E. (2011). The renewable energy consumption–growth nexus in Central America. *Applied Energy, 88*(1), 343-347. doi:10.1016/j.apenergy.2010.07.013

Apergis, N., Payne, J. E., Menyah, K., & Wolde-Rufael, Y. (2010). On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. *Ecological Economics, 69*(11), 2255-2260. doi:10.1016/j.ecolecon.2010.06.014

Bakhtyar, B., Kacemi, T., & Nawaz, M. A. (2017). A review on carbon emissions in Malaysian cement industry. *International Journal of Energy Economics and Policy, 7*(3), 282-286.

Baloch, Z. A., Tan, Q., Kamran, H. W., Nawaz, M. A., Albashar, G., & Hameed, J. (2021). A multi-perspective assessment approach of renewable energy production: policy perspective analysis. *Environment, Development and Sustainability*, 1-29.

Baltagi, B. H., Fomby, T. B., & Hill, R. C. (2000). *Nonstationary panels, panel cointegration, and dynamic panels*: JAI.

Ben Jebli, M., Ben Youssef, S., & Ozturk, I. (2015). The role of renewable energy consumption and trade: Environmental kuznets curve analysis for sub-saharan Africa countries. *African Development Review, 27*(3), 288-300. doi:10.1111/1467-8268.12147

Bilgili, F., & Ozturk, I. (2015). Biomass energy and economic growth nexus in G7 countries: Evidence from dynamic panel data. *Renewable and Sustainable Energy Reviews, 49*, 132-138. doi:10.1016/j.rser.2015.04.098

Chien, F., Sadiq, M., Nawaz, M. A., Hussain, M. S., Tran, T. D., & Le Thanh, T. (2021). A step toward reducing air pollution in top Asian economies: The role of green energy, eco-innovation, and environmental taxes. *Journal of environmental management, 297*, 113420.

Dogan, E., & Seker, F. (2016). An investigation on the determinants of carbon emissions for OECD countries: empirical evidence from panel models robust to heterogeneity and cross-sectional dependence. *Environmental Science and Pollution Research, 23*(14), 14646-14655. doi:10.1007/s11356-016-6632-2

Erdil, E., & Yetkiner, I. H. (2009). The Granger-causality between health care expenditure and output: a panel data approach. *Applied Economics, 41*(4), 511-518. doi:10.1080/00036840601019083

Farhani, S., & Ozturk, I. (2015). Causal relationship between CO 2 emissions, real GDP, energy consumption, financial development, trade openness, and urbanization in Tunisia. *Environmental Science and Pollution Research, 22*(20), 15663-15676. doi:10.1007/s11356-015-4767-1

Fazal, S., Gillani, S., Amjad, M., & Haider, Z. (2020). Impacts of the Renewable-Energy Consumptions on Thailand's Economic Development: Evidence from Cointegration Test. *Pakistan Journal of Humanities and Social Sciences, 8*(2), 57-67.

Furuoka, F. (2015). The CO2 emissions–development nexus revisited. *Renewable and Sustainable Energy Reviews, 51*, 1256-1275. doi:10.1016/j.rser.2015.07.049

Ghorashi, N., & Rad, A. A. (2017). CO2 emissions, health expenditures and economic growth in iran: application of dynamic simultaneous equation models. *growth, 9*, 11.

Hasanov, F. J., & Mikayilov, J. I. (2017). The impact of age groups on consumption of residential electricity in Azerbaijan. *Communist and Post-Communist Studies, 50*(4), 339-351. doi:10.1016/j.postcomstud.2017.09.005

Inglesi-Lotz, R. (2016). The impact of renewable energy consumption to economic growth: A panel data application. *Energy Economics, 53*, 58-63. doi:10.1016/j.eneco.2015.01.003

Jalil, A., & Mahmud, S. F. (2009). Environment Kuznets curve for CO2 emissions: a cointegration analysis for China. *Energy policy, 37*(12), 5167-5172. doi:10.1016/j.enpol.2009.07.044

Jaunky, V. C. (2011). The CO2 emissions-income nexus: evidence from rich countries. *Energy Policy, 39*(3), 1228-1240. doi:10.1016/j.enpol.2010.11.050

Javid, M., & Sharif, F. (2016). Environmental Kuznets curve and financial development in Pakistan. *Renewable and Sustainable Energy Reviews, 54*, 406-414. doi:10.1016/j.rser.2015.10.019

Jebli, M. B., & Youssef, S. B. (2015). The environmental Kuznets curve, economic growth, renewable and non-renewable energy, and trade in Tunisia. *Renewable and Sustainable Energy Reviews, 47*, 173-185. doi:10.1016/j.rser.2015.02.049

Jebli, M. B., Youssef, S. B., & Apergis, N. (2015). The dynamic interaction between combustible renewables and waste consumption and international tourism: the case of Tunisia. *Environmental Science and Pollution Research, 22*(16), 12050-12061. doi:10.1007/s11356-015-4483-x

Jebli, M. B., Youssef, S. B., & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. *Ecological Indicators, 60*, 824-831. doi:10.1016/j.ecolind.2015.08.031

Jerrett, M., Eyles, J., Dufournaud, C., & Birch, S. (2003). Environmental influences on healthcare expenditures: an exploratory analysis from Ontario, Canada. *Journal of Epidemiology & Community Health, 57*(5), 334-338. doi:10.1136/jech.57.5.334

Jianjun, H., Yao, Y., Hameed, J., Kamran, H. W., Nawaz, M. A., Aqdas, R., & Patwary, A. K. (2021). The Role of Artificial and Nonartificial Intelligence in the New Product Success with Moderating Role of New Product Innovation: A Case of Manufacturing Companies in China. *Complexity, 2021*, 14.

Kao, C., & Chiang, M.-H. (1999). On the estimation and inference of a cointegrated regression in panel data. *Available at SSRN 1807931*.

Li, W., Chien, F., Hsu, C.-C., Zhang, Y., Nawaz, M. A., Iqbal, S., & Mohsin, M. (2021). Nexus between energy poverty and energy efficiency: Estimating the long-run dynamics. *Resources Policy, 72*, 102063.

Lu, Z.-N., Chen, H., Hao, Y., Wang, J., Song, X., & Mok, T. M. (2017). The dynamic relationship between environmental pollution, economic development and public health: Evidence from China. *Journal of Cleaner Production, 166*, 134-147. doi:10.1016/j.jclepro.2017.08.010

Mark, N. C., & Sul, D. (2003). Cointegration vector estimation by panel DOLS and long-run money demand. *Oxford Bulletin of Economics and statistics, 65*(5), 655-680. doi:10.1111/j.1468-0084.2003.00066.x

Menyah, K., & Wolde-Rufael, Y. (2010). CO2 emissions, nuclear energy, renewable energy and economic growth in the US. *Energy Policy, 38*(6), 2911-2915. doi:10.1016/j.enpol.2010.01.024

Mohsin, M., Kamran, H. W., Nawaz, M. A., Hussain, M. S., & Dahri, A. S. (2021). Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. *Journal of environmental management, 284*, 111999.

Nawaz, M. A., Ahmad, T. I., Hussain, M. S., & Bhatti, M. A. (2020). How Energy Use, Financial Development and Economic Growth Affect Carbon Dioxide Emissions in Selected Association of South East Asian Nations? *Paradigms*(SI), 159-165.

Nawaz, M. A., Azam, A., & Bhatti, M. A. (2019). Natural Resources Depletion and Economic Growth: Evidence from ASEAN Countries. *Pakistan Journal of Economic Studies, 2*(2), 155-172.

Nawaz, M. A., Azam, M. A., & Bhatti, M. A. (2019). Are Natural Resources, Mineral and Energy Depletions Damaging Economic Growth? Evidence from ASEAN Countries. *Pakistan Journal of Economic Studies, 2*(2).

Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics, 36*, 262-267. doi:10.1016/j.eneco.2012.08.025

Pedroni, P. (2001). Purchasing power parity tests in cointegrated panels. *Review of Economics and statistics, 83*(4), 727-731. doi:10.1162/003465301753237803

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory, 20*(3), 597-625. doi:10.1017/S0266466604203073

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. doi:10.1016/j.jclepro.2017.08.010

Shahbaz, M., Tiwari, A. K., & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. *Energy Policy, 61*, 1452-1459. doi:10.1016/j.enpol.2013.07.006

Shair, F., Shaorong, S., Kamran, H. W., Hussain, M. S., Nawaz, M. A., & Nguyen, V. C. (2021). Assessing the efficiency and total factor productivity growth of the banking industry: do environmental concerns matters? *Environmental Science and Pollution Research, 28*(16), 20822-20838.

Solarin, S. A., Al-Mulali, U., Musah, I., & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: an empirical investigation. *Energy, 124*, 706-719. doi:10.1016/j.energy.2017.02.089

Sun, H., Awan, R. U., Nawaz, M. A., Mohsin, M., Rasheed, A. K., & Iqbal, N. (2021). Assessing the socio-economic viability of solar commercialization and electrification in south Asian countries. *Environment, Development and Sustainability, 23*(7), 9875-9897.

USAID. (2009). ECO-III Project, Energy Efficiency in Hospitals: Best Practice Guide, International Resources Group, New Delhi, India.

World Bank, W. (2020). The World Bank. Retrieved from https://databank.worldbank.org/source/world-development-indicators

World Health Organization, W. (2011). *Health in the Green Economy: Co-benefits to Health of Climate Change Mitigation: Household Energy Sector in Developing Countries*. Retrieved from http://www.who.int/hia/green_economy/en/

World Health Organization, W. (2015). *Health in the Green Economy*. Retrieved from http://www.who.int/hia/green_economy/en/index.html

Xiang, H., Ch, P., Nawaz, M. A., Chupradit, S., Fatima, A., & Sadiq, M. (2021). Integration and economic viability of fueling the future with green hydrogen: An integration of its determinants from renewable economics. *International Journal of Hydrogen Energy, 46*(77), 38145-38162.