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The Impact of Renewable Energy and Economic Development on Environmental Quality of ASEAN Countries

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Maintaining the quality of environmental is a global requirement and necessary to achieve high economic growth, especially through the use of bioenergy. This eco-significant requirement has gained the focus of recent studies and regulators. Following suit, the present study examines the impact of bioenergy production, biomass production, energy import, energy export, and economic development on the carbon emission of the ASEAN countries. This study extracts secondary data from published material such as World Development Indicators (WDI) from 2004 to 2019. This study has run the generalized method of moments along with the random effect model to test the relationships between the constructs. The study reveals that bioenergy production, biomass production, energy import, energy export, and economic development have a negative association with carbon emission or positive association with environmental quality of the ASEAN countries. This study can support future research studies on the subject help regulators formulate and implement policies related to bioenergy production, biomass production, and carbon emission.

Keywords: Bioenergy production, Biomass production, Energy import, Energy export, Economic development, Carbon emission, Environmental quality

1. INTRODUCTION

Environmental quality is a characteristic associated with numerous properties and elements. A number of energy factors contribute to the assessment of the quality of the environment. These factors are part of the local and international environment which is sustained by organisms and human beings. Measurement environmental quality depends on the uses of energy which are the main contributors to degradation and retaining of the atmosphere. There are sustainable potential resources prevalent in ASEAN countries for liquid biofuels. Various estimations are also converted and collected by emphasizing the feedstock which could be converted to biofuels. The focus is on the growth of feedstock that is environmentally and socially sustainable for bioenergy production. Without any conflict persisting between the causing usage of land and food supplies, the release of carbon could contribute towards global warming. Numerous approaches about biomass feedstock include various items. These items are consistently helping in the development of biomass feedstock from the products generated in forests and farms. Proper implementation of strategies for the plantation and grasses could be beneficial for the biomass but potentially harmful when burnt. Growing food could be a positive approach for human welfare and for establishing a positive environment (Ali et al., 2019; Ridzuan et al., 2017).

Environment quality exerts a strong impact on different aspects of life. ASEAN, like other countries and international environment protection agencies in the world, is particular careful about environmental aspects. ASEAN almost annually reports on environmental issues in way of updating the Environmental Declaration (SOER). In 1997, the first SOER of ASEAN released, covering the then-seven ASEAN Member States (AMS). A second ASEAN SOER covering all the latest ten AMS has been released three years back. In 2006, the third SOER was released. The 5th ASEAN SOER (2017) (SOER5) was published in 2010, following the 4th SOER (2009). Atmospheric research in ASAAN indicates that regional air pollution is on the rise, with the oil industry accounting for the highest level of emissions of carbon dioxide with energy associated levels of carbon dioxide emissions projected to rise by 61% in 2014 to 2025 in the ASEAN region. The cities are key greenhouse gas sources on account of urban lifestyle and its impact on the environment, and ASEAN cities need to seek low carbon economy, services, and transport as a matter of urgency. Improved monitoring and higher standards of air quality are also important in all AMS so that trends in air quality can be properly tracked and adhered to. ASEAN countries are also linked to the rise of tourism fires leading to the proliferation of major commercial plantations of up to 90% of trans boundary smoke haze. Although solutions to haze emissions are in place, it is important to implement more holistic steps to resolve this problem at the source through proper land use and management as well as restrictions on commercial plant growth. Moreover, it bears to note that according to the environmental performance index, the ASEAN nations secure different scores. For instance, Laos rank is 130 with a score of 34.8 while the rank scored by Malaysia is 68 with a score of 47.9. In the same way, Thailand's rank is 78 with a score of 45.4. Philippine rank is 111 with a score of 38.4. Similarly, Indonesia ranks at 116 with a score of 37.8 and Vietnam ranks at 139 with a

score of 33.4. Another ASEAN member Cambodia's rank is 139 with a score of 33.6 and the Myanmar rank's is 179 with a score is 25.1. The pollution index of ASEAN nations is shown in Figure 1.

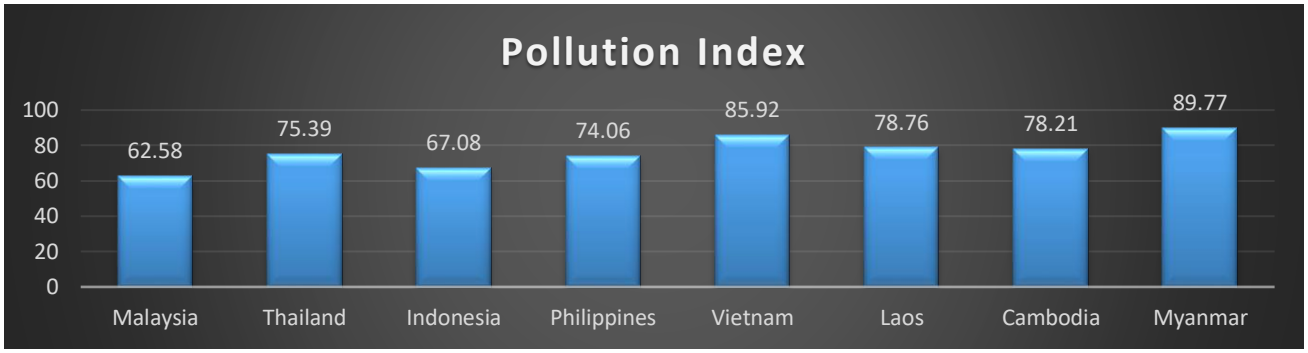

Figure 1: Pollution Index of ASEAN Nations

The import of energy determines the proportion of energy consumption which is imported or produced domestically. Therefore, the emergence of energy imports benefits ASEAN countries and also depicts their effects on the environment. Some tolerable energy elements could also have positive ramifications for the development of the environment, ultimately uplifting living conditions and quality of life. This depends on the inland energy consumption which requires countries to initiate the process of importing energy from other countries. Exporting energy to other countries is an important means of uplifting the local economy (Gong, 2019; Tancho, Jermsittiparsert, & Chienwattanasook, 2021). This uplifting not only fosters healthier economic conditions but also plays an important role in the maintenance of environmental quality. Various types of energy are imported which include electricity, solar, coal, and generator. Energy import is eminent for implementing sustainable measures to retain environmental quality and encourage prominent modes for the enhancement of production of energy. The economic growth of any country is essential to ensure provision of human benefits and retain environmental quality for all regions. Since the past few decades, the economic growth of the world has been highlighted around the globe due to the significant changes observed in the natural environment. This increased level sustainability of the environment is also an upshot of the positive economic development where humans are increasingly undertaking significant efforts to ensure environmental sustainability (Haseeb, Kot, Hussain, & Jermsittiparsert, 2019; Zandi, Haseeb, & Abidin, 2019). As environmental quality is prevalent in many properties and elements. Many of these contributors to the efficiency of the atmosphere are complex energy sources. Within the local and foreign ecosystems assisted by species and human beings, certain features prevail. Contamination or degradation of environmental quality ultimately depends on the energy components that contribute to atmospheric depletion and retention.

2. LITERATURE REVIEW

To assess the impact of gas emissions caused by biofuels, while replacing fossil fuels, it is important to understand the whole process of bioenergy production. Renewable energy is coming from the working on fossil fuels, which asserts its impact on the ASEAN environment. The process works differently while focusing on the quality of the environment; therefore, a system of biofuel is an important one in terms of influence on environment quality. Some isolations have been depicted in the production and removal of biofuels which are naturally strained all over the world (Ibrahim, Al-Thukair, Shaikh, Farooq, & Ahmad, 2020). By using gases, the bioenergy production can be significantly enhanced but this poses an adverse influence on the quality of the environment. There are balances of greenhouse gasses which when fluctuated, can significantly impact the environment. This impact ultimately depends upon the types of crops and energy elements that are used to produce biofuels in ASEAN countries, even though, fossil fuels are relatively less influential than biofuels contributing to gas emissions. Various tools are specifically controversial while emphasizing the impact of biofuels on the quality of the environment. Among the optimization and modeling of artificial networks for bioenergy production, the resources of the environment and fossil fuels are considered (Sewsynker-Sukai, Faloye, & Kana, 2017). Therefore, sustainable energy is friendly in relation to the environment as well as on account of the availability of bioenergy sources. Various factors contribute to gas emissions of greenhouse which, correspondingly depicts the amount of fossil fuel energy dominant in the production of ASEAN biofuels. These emissions are considerably prevalent during the production of biofuel which adversely influences the environment in multiple ways. While transporting, feedstock production, and manufacture of pesticide and fertilizer, and for the production of biofuel itself, fossil fuels play a vital role. Certain functional approaches are used to generate the sources of bioenergy production which could be feasible for the economy and industry (Tiwari, Nain, Labrou, & Shukla, 2018). This

generation of bioenergy production is considered an option for alternative and sustainable energy. While mitigating the effects of climate change, various factors are taken into consideration in ASEAN countries. The factors are significantly prevalent in the portion of energy and renewable energy elements. Such renewable energy factors positively contribute to the quality of the environment. The emissions of gasses also have a significant impact on the environment. In the evaluation of environmental quality, the production of biofuel is marked as an important one with a significant impact in changing climates. In evaluating the link between the demand for energy, agriculture, environmental degradation, and finance, the quality of the environment is seen to play an important role (Hafeez et al., 2020). This is a clear indication of the paradigm trend towards the development of energy sources while considering their impact on the quality of the environment.

Environmentally unfriendly use of energy resources in ASEAN countries is attributable to a number of factors. The energy-related to biomass is usually generated from alternative sources which include natural gases, petroleum, and coal. While burning fossil fuels, certain gasses are extracted from the environment in consideration of biomass as in carbon dioxide and greenhouse gases. The production of biomass is significantly related to stem roundness and canopy structure in the popularity of plantation (Tun, Guo, Fang, & Tian, 2018). This is a possible means for the improvement of wood quality and productivity by substantiating the dominant impact of use of energy resources on the environment quality. While enumerating the positive approach toward the production of biomass, the plant is considered an eminent source of energy. It also produces a huge amount of carbon dioxide when plants are burnt in ASEAN countries due to forestry areas. Using different types of burning woods is also a dominant source of energy. Forests are the main areas which are used for the production of biomass. Biomass production is organic fertilization which takes place in the cultivation from tropical soil (Diallo, Masse, Diarra, & Feder, 2020). This enhances the known versions or models of biomass production which are influential vis-a-vis the quality of the environment. Particularly, the impacts on the environment are generated from biomass burning which is used to form electricity. Various power plants are used as biofuels and biomass which is taken from forests in ASEAN countries. Biomass is generated from the various fossil fuels and coals which generate huge gasses to the environment and can potentially result in climate change. The sequence of carbon and biomass production stands in sync with the forestry principles which are essential for the quality of the environment (Hytönen, Aro, & Jylhä, 2018). Deforestation could significantly decrease biomass production which, in turn, could be beneficial for the environment. Usually, policies developed for the environment establish the feasibility of gasses in terms of the protection of environment and human health in ASEAN countries. This is done by reducing the amount of fossil fuel burning which is the main source of biomass. Various traps are prevalent in the environment which may be disrupted by the numerous gases during the process of burning or releasing carbon dioxide. Therefore, the combustion of biomass significantly impacts the quality of air and poses various health risks. Among the ASEAN countries, Malaysian environmental quality is significantly linked with the change in energy prices (Maji, Habibullah, Saari, & Abdul-Rahim, 2017). This link the higher prices of oil rendering emission of carbon and improvement with the quality of the environment.

Energy import is a major factor affecting environment quality. Usually, multiple energy items are imported to the ASEAN countries which can potentially impact the environment. These items include various components of energy like fossil fuels, gasses, and crude oil which impact the climate. Therefore, environmental quality is a major concern in the import of energy. The trade aspects of China are more pronounced due to the decompositions of structural reforms and significant extractions of methods for energy import (Deng, Ma, Zhang, & Liu, 2018). While exploring the norms of energy import, the quality of the environment is embodied with the import of energy which is based on various items. Many countries are indulged in the import of energy due to a lack of domestic production. It not only costs the countries but also impacts the quality of the environment. ASEAN countries are major producers of energy resources but are also, at the same, involved in the import synergies. Usually, the import of energy is depicted in many developing countries and the countries with weak economies. The substitution of import technology is referred to the energy where the equipment is traded in the Russian energy sector (Kryukov, 2017). Various cycles are introduced in the energy industry that depict the application and implementation of technological developments. Due to lesser production of energy domestically, developing countries are forced to buy energy from developed countries. ASEAN countries are indulged in the import of electrical energy as well as in imports of crude oil. The market of energy import is largely operated in the global world but also poses a significant influence on the quality of the environment. Wide interactions have been elaborated between the imports and consumption of energy in Turkey (Katircioglu, Katircioğlu, & Altinay, 2017). Over the years, significant impacts of energy import are seen on the quality of the environment with local and renewable energy resources. Environment quality is directly linked with the energy imports due to having plenty of health issues. Although, importing energy is considered necessary to meet the country's energy demands some ASEAN countries are able to in produce enough energy domestically. Malaysia and Singapore are among the largest producers of energy as compared to other ASEAN countries. Therefore, the trend to import energy has significantly increased in some years with a correspondingly increasing impact on the quality of the environment. Since energy efficiency is significant in improving the total factor productivity, thus

improvement in the efficiency of energy, the controlled demands of the Hong Kong system of temperature provided acceptance of environmental quality (Mui, Wong, Cheung, & Yu, 2017). This is dependent on the policy development for energy import that incorporated the role of energy consumption with the environment.

Exporting energy is also considerably increased in many countries because of its contribution to the economy. Although, energy has several consequences for the environment, it also brings several benefits. This wide interpretation highlights positive contexts of energy export to support economy as well as to maintain the climate. The patterns of energy export are analyzed with the independence of the commonwealth in China with the relevance of environmental quality (Rasoulinezhad, 2019). This applies to the gravity of energy export in most of the ASEAN countries which are persistent in maintaining the environmental quality. The quality of the environment has increased in developing countries due to a large number of exports. These exports are linked with economic benefits and the quality of the environment. International policies are developed in the ASEAN countries to undertake various measures which are beneficial for the enhancement of energy exports. Certain strategies and views have also been depicted in the energy export that significantly influence environment quality. It is upon the acceptance of the public which is aware of the energy wind that is used to enhance export in Ireland with the means of effectiveness and flexibility (Brennan, Van Rensburg, & Morris, 2017). Local communities play an important role in terms of the impact of energy export on the environment. China is considered the largest exporter of energy due to its vast facilities and broader ways. This immense export of energy has been depicted in many developed countries because of their largest production. The involvement of ASEAN countries in energy export has also been considerably increased by prioritizing impact on environmental quality. Over the past few decades, energy export has peaked due to its wide usage and demand in many countries. The revolution of energy export is examined among Africa and China with the development of energy capacity (Shen & Power, 2017). Transferring the energy into other countries is also causing a significant influence on the quality of the environment. Among the largest exporters of energy, ASEAN countries significantly dominate in this area due to their wide resources. This states the outputs which have been increased due to significant inputs whether attained domestically or internationally. It intensifies its impact on the environment quality with a variation due to consumption and exports. Although elements of import also prevail, the consumption variance could significantly counter the quality of the environment. The saving of energy is a better endorsement for indoor environment having no effects on human health (Raw, Littleford, & Clery, 2017). Several comfort zones have been established in ASEAN countries that are maintaining and sustaining environment quality.

Quality of environment has a direct impact on human development. Income generation of individuals or households can also be potentially influenced by the quality of the environment. ASEAN countries have attained significant economic growth and have reduced the level of pollution in the environment. There are winning and losing aspects for environmental sustainability as well as economic development with certain redevelopments (Howell, 2020). On the basis of economic development, the environment quality is maintainable when feasible policies are developed. Economic growth remains steady by endorsing a significant impact on the quality of the environment. An alarming situation could be created where the environmental quality is disrupted by the inequality in economic conditions. Certain measures prevail in the environment quality which require proper management of economic development. In some ASEAN countries, economic development is evaluated as a positive indicator of environmental quality. While ascertaining the development of economy, environmental development is dependent on international policies (Han, 2017). When there is an increase in energy consumption, a significant impact on economic growth could be seen. Although, a main contributor to the economy it also helps improve the quality of the environment. It is contingent upon the increment in consumption of renewable and non-renewable resources which renders an impact on the environment quality. Potential losses may also occur due to insignificant variance in economic development. In the discussion of environmental degradation, and financial and economic development, the impacts on small developing states are certain (Seetanah et al., 2019). These impacts are determined from the behavioral aspects of economic conditions which fluctuate with the validation of environmental quality. The enhanced consumption of energy resources with the highest levels of pollution and global warming endorses a negative impact on the habitats of the environment. Economic development could be enhanced significantly by lowered levels of pollution and improvements in technology. This wide consideration of economic growth in ASEAN countries is eminent for improving the quality of the environment. Various routes are designed for energy saving as well as maintain environmental quality that are natural due to ventilated income variation (Sarkar & Bardhan, 2020). Different improvements in economic development significantly enhance the experience of the environment that could harm the potentials of energy.

3. RESEARCH METHODS

The ongoing study explores the influence of bioenergy production, biomass production, energy import, energy export, and economic development on the carbon emission of the ASEAN countries. This study has extracted secondary data from published sources such as WDI for the years 2004 to 2019. This study has identified the environmental quality as a dependent variable while bioenergy production, biomass production, energy import,

and energy export have been used as predictors, and economic development has been used as a control variable. These constructs are used to develop the following equation:

$$CO2_{it} = \alpha_0 + \beta_1 BEP_{it} + \beta_2 BMP_{it} + \beta_3 EI_{it} + \beta_4 EE_{it} + \beta_5 ED_{it} + e_{it} \quad \textbf{(1)}$$

Where;

CO2 = Carbon Emission

i = Country

t = Time Period

BEP = Bioenergy Production

BMP = Biomass Production

EI = Energy Import

EE = Energy Export

ED = Economic Development

The environmental quality is measured in terms of the level of CO2 emission from electricity and heat production (% total fuel consumption). Moreover, bioenergy production is measured as the bioenergy production (% of total energy production), biomass production is measured as the biomass production (% of total energy production), energy import is measured as the energy import (% of energy use), energy export is measured as the energy export (% of energy use), and economic development is measured in terms of = GDP growth (annual %). These constructs, along with measurements, have been mentioned in Table 1

Table 1: Measurements of Variables

S#	Variables	Measurements
01	Environment Quality	CO2 emission from electricity and heat production (% total fuel consumption)
02	Bioenergy Production	Bioenergy production (% of total energy production)
03	Biomass Production	Biomass production (% of total energy production)
04	Energy Import	Energy import (% of energy use)
05	Energy Export	Energy export (% of energy use)
06	Economic Development	GDP growth (annual %)

This study shows descriptive statistics including, mean values along with standard deviation, maximum and minimum values. Furthermore, the current research also indicates that there is a nexus among the constructs by using a correlation matrix. If the values of the matrix show a negative sign that points to negative association; conversely, if values show positive signs that points to a positive association between the variables. This study also determines the appropriate model for the study by using the Hausman test. The thumb role is that if the probability value of the Hausman test is higher than 0.05, then accept H0 and the REM is deemed suitable, but if probability values are lower than 0.05, then it rejects H0, and the fixed effect model is suitable. The present study has executed the REM, and the equations for REM is given below:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \varepsilon_i + u_{it} \quad \textbf{(2)}$$

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + w_{it} \quad \textbf{(3)}$$

The equation (3) shows the $w_{it} = \varepsilon_i + \mu_{it}$ and ε_i that exposes the individual-specific error component while μ_{it} exposes the time-series error component. The equation of REM for the given variables is as follow:

$$C02_{it} = \beta_1 + \beta_2 BEP_{it} + \beta_3 BMP_{it} + \beta_4 EI_{it} + \beta_5 EE_{it} + \beta_6 ED_{it} + w_{it} \quad \textbf{(4)}$$

The current study also runs the generalized method of moments (GMM) to test the relationships between the constructs due to the model has heterogeneity issues. The estimations for the GMM model have been provided below:

$$Y_{it} = \delta Y_{i,t-1} + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + u_{it} + \varepsilon_{it} \quad \textbf{(5)}$$

This study adopts the GMM model due to its specific features that control the autocorrelation and heteroscedasticity effects on the results, and the estimation equation for GMM is given as under:

$$CO2_{it} = \delta CO2_{i,t-1} + \beta_1 BEP_{it} + \beta_2 BMP_{it} + \beta_3 EI_{it} + \beta_4 EE_{it} + \beta_5 ED_{it} + u_{it} + \varepsilon_{it} \quad \textbf{(6)}$$

4. FINDINGS

Table 2 presents descriptive statistics that show mean values along with standard deviation, maximum and minimum values. The average value of CO2 is 1.645, while BEP on average is 0.551. Moreover, the average value of BMP is 0.262, and on average, energy import is 0.146. In addition, the average EE is 0.108, and the average ED is 2.289.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	160	1.645	0.571	0.179	3.437
BEP	160	0.551	0.343	0.199	0.785
BMP	160	0.262	0.275	0.012	0.846
EI	160	0.146	0.209	0.002	0.983
EE	160	0.108	0.189	0.062	0.399
ED	160	2.289	1.714	1.450	5.836

The current study also demonstrates the nexus among the constructs by using a correlation matrix. The statistics above illustrate that bioenergy production, biomass production, energy import, energy export, and economic development have a negative association with the carbon emission of the ASEAN countries. These statistics are highlighted in Table 3.

Table 3: Correlation Matrix

Variables	CO2	BEP	BMP	EI	EE	ED
CO2	1.000					
BEP	-0.250	1.000				
BMP	-0.062	-0.429	1.000			
EI	-0.195	-0.481	-0.207	1.000		
EE	-0.224	0.588	-0.246	-0.069	1.000	
ED	-0.585	-0.033	0.083	0.113	0.332	1.000

This study also checks the appropriate model for the study by using the Hausman test. The thumb role is that if the probability value of the Hausman test is higher than 0.05, then the researcher shall accept H0 and REM as suitable, but if probability values are lower than 0.05, then it rejects H0, and the fixed effect model is deemed suitable. The statistics highlight that the value of probability is 0.134, which is higher than 0.05, and accepts the H0 that shows REM is suitable. These figures are shown in Table 4.

Table 4: Hausman Test

	Coef.
Chi-square test value	12.029
P-value	0.134

Firstly, the present study checks the nexus with REM, and the results show that bioenergy production, biomass production, energy import, energy export, and economic development have a negative association with carbon emission or a positive association with the environmental quality of the ASEAN countries. The R square value is 0.536, highlighting that 53.6 percent changes in CO2 are due to bioenergy production, biomass production, energy import, energy export, and economic development. These figures are shown in Table 5.

Table 5: Random Effect Model (REM)

CO2	Beta	S.D.	t-value	p-value	L.L.	U.L.	Sig
BEP	-0.703	0.102	-6.86	0.000	-0.904	-0.502	***
BMP	-0.735	0.178	-4.14	0.000	-1.083	-0.387	***
EI	-0.619	0.237	-2.61	0.009	-1.084	-0.155	***
EE	-0.274	0.070	-3.90	0.000	-0.937	-0.412	***
ED	-0.014	0.002	-7.19	0.000	-0.910	-0.018	***
Constant	6.407	0.742	8.63	0.000	4.952	7.862	***
Overall r-squared	0.536	Number of obs	160.000				
Chi-square	151.197	Prob > chi2	0.000				
R-squared within	0.461	R-squared between	0.724				

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

Finally, the present study checks the nexus with GMM, and the outcomes reveal that bioenergy production, biomass production, energy import, energy export, and economic development have a negative association with carbon emission or a positive association with the environmental quality of the ASEAN countries because the beta has

negative signs. The nexus among the bioenergy production, biomass production, energy import, energy export, economic development, and carbon emission is significant because the p-values are less than 0.05, and t-values are greater than 1.64. These figures are highlighted in Table 6.

Table 6: Generalized Method Moments (GMM)

CO2	Beta	S.D.	t-value	p-value	L.L.	U.L.	Sig
BEP	-0.626	0.126	-4.96	0.000	-0.875	-0.376	***
BMP	-0.506	0.238	-2.13	0.017	-0.677	-0.264	**
EI	-0.663	0.287	-2.31	0.008	-0.931	-0.204	**
EE	-0.349	0.123	-2.83	0.005	-0.906	-0.593	***
ED	-0.016	0.002	-8.82	0.000	-0.112	-0.019	***
Mean dependent var		1.655	SD dependent var		0.573		
Number of obs		150.000	F-test		31.512		

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

5. DISCUSSION AND IMPLICATION

The present study also examines the impact of bioenergy production, biomass production, energy import, energy export, and economic development on the carbon emission of the ASEAN countries. It has been indicated by the study outcomes that biomass production has a positive relationship with environmental quality. Biomass is produced from the biological material which has absorbed and stored light from the sun and helps to lower the level of carbon dioxide present in the atmosphere. Thus, biomass production lowers the Earth's heat/temperature and minimizes the amount of harmful gas in the air. These results are in line with the past study by Mao, Huang, Chen, and Wang (2018). This study examines the environmental quality of different countries, and the factors which worsens environmental quality i.e. emission of carbon dioxide and greenhouse gases. Finally, it suggests that environmental quality can be maintained by encouraging the use of biomass production to meet the energy requirements. As biomass resources are pollution-free and also help to remove environmental pollutants; therefore, through the production and use of biomass, the environment is more likely to remain safe and protected. These results are also in line with a past study by Bilgili, Koçak, Bulut, and Kuşkaya (2017), which indicates that the use of biomass energy is more friendly for the environment as compared to non-renewable fossil fuel energy because the production of biomass energy does not have any negative impacts on the environment; in fact, the forestation and plantation help to keep the atmosphere and land safe from pollutants. For this reason, biomass energy production keeps the environment safe from contaminating wastes and maintains environmental quality.

The study results indicate that biofuel energy production has positive impacts on environmental quality. Biofuel is the liquid or gaseous form of energy produced from forests, plants, or crops, which themselves are pollution-free, and the process of generating biofuel energy from these renewable resources is also safe. Thus, the production of biofuel energy is helpful in maintaining environmental quality. These results are supported by the literary work of Li, Watson, Zhang, Lu, and Liu (2020), which indicates that the production of biofuel is a safe way to meet domestic and commercial energy requirements because biofuel such as bioethanol and biodiesel is produced from pollution-free food-based and non-food-based crops. These results are also in line with a previous study by Joshi, Pandey, Rana, and Rawat (2017). This study throws light on the contribution of biofuel energy production to the environmental quality of any country. As compared to non-renewable energy resources, the production of biofuel does not add to carbon emission, sulfur emission, and the emission of other greenhouse gases into the air, and therefore, biofuel protection helps in maintaining environmental quality. The study results also indicate that energy import is considerably linked with the environmental quality of a country. The import of renewable energy resources is linked the environmental quality in a positive manner, while the import of non-renewable energy resources affects the environmental quality in a negative manner. These results are in line with the past study conducted by Gokten and Karatepe (2016), which shows that bringing energy sources from foreign countries affects the environmental quality of the country. The import of renewable energy resources like biomass and biofuel in place of non-renewable energy sources like fossil fuels and nuclear power protects the atmosphere, natural resources, and most importantly, the health of living beings. These results are also supported by the study of Moreno and García-Álvarez (2017), which posits that with the import of renewable energy resources, the domestic environment can be kept safe from environmental pollutants.

The import of renewable energy sources creates a protective work environment for the workforce. On the other hand, renewable energy sources are likely to contaminate the environment. The study results reveal that the export of energy sources has a significant impact on environmental quality. The results are supported by a past study by Shakeel and Ahmed (2020), which reveals that the export of renewable energy resources like biomass and biofuel, increases the amount of forestation and plantation within the country, and thus, improves the environmental

quality. On the other hand, the export of non-renewable energy (energy from the burning of fossil fuels) affects the environmental quality negatively as it creates environmental pollutants within the country. These results are also supported by the study of Girard, Gago, Ordoñez, and Muneer (2016), which shows that the export of energy raises the productivity of both renewable and non-renewable energy, which affects the environmental quality accordingly. The study results have also shown that the economic development of a country has a positive association with environmental quality. These results are supported by the study of Baloch, Mahmood, and Zhang (2019), which shows that the countries which have a high rate of economic development have a sound financial position and, thus, can launch different ecological programs to tackle environmental issues. These results are also supported by the study of Charfeddine and Mrabet (2017) which shows that when a country's economy is developing at a fast pace, there is more productivity, and correspondingly, more earnings. These earnings enable the country to handle environmental pollution by launching different environmental campaigns to raising awareness in public regarding the environment, checking the environmental issues, and trying to get rid of these issues.

This study carries several theoretical and empirical implications or lessons. The study has theoretical significance as it initial substantially adds to the literature on environmental protection. In the past, very little focus has been put on the combined contribution of the biological and economic factors to the quality of environment. This study is one of the pioneer attempts to explore both, he biological and economic factors in this regard. It deals with two biological factors like biomass and biofuel production and three economic factors such as energy import, energy export, and economic development, analyzing their impacts on the quality of natural resources, atmosphere, and the health of living beings. Moreover, this literary article proves to be very useful to the ecologist and economists in developing countries because of the provision of proper guidance on how to maintain environmental quality. This study is potentially helpful for studies seeking to explore this area in the future as well as for regulators while formulating and implementing policies related to bioenergy production, biomass production, and carbon emission. The study posits that with the production of biomass and biofuel energy resources, good environmental quality can be maintained by reducing the emission of harmful gases into the air. Moreover, environmental quality can be sustained and improved through the proper management of import and export of energy resources. Moreover, this study also provides guidance on how to maintain good environmental quality while also achieving a high rate of economic development.

6. CONCLUSION AND IMPLICATIONS

The main focus of the current study is on the development and maintenance of environmental quality. The study analyzes the environmental quality of different areas within ASEAN countries and seeks to determine the impact of different biological factors like biomass and biofuel production as well as economic factors such as energy import, energy export, and economic development of the environmental quality. The study examines that the inclination of the domestic governments and commercial entities to produce and use biomass energy proves to be helpful in maintaining good environmental quality. As biomass energy is generated from utilizing biological material which is absorbed and stores the light from the sun and reduces the carbon dioxide emission into the air, it minimizes the Earth's heat and keeps the environment healthy. Similarly, the production of biofuel also helps in maintaining environmental quality. Since the biofuel energy (the gaseous or liquid form of energy) is produced from plants, and crops, it is also are environment-positive for the atmosphere and land. Moreover, the production procedure of biofuel energy is also safe, which means that biofuel production does not adversely affect environmental quality. Moreover, the study highlights that both, the import and export of energy sources affects inland environmental quality. The import and export of renewable energy sources like biomass and biofuel do not adversely affect the environment, but they help to protect the environment against pollution. Contrary to this, the import and export of non-renewable energy sources have an adverse impact on the environment. This study suggests the countries which have high economic development can actively run environmental campaigns and maintain environmental quality.

Although the present study has a number of theoretical and empirical implications, it has certain limitations as well. The authors put intellectual effort to overcome these limitations. Firstly, only a limited number of biological factors such as biomass and biofuel production and economic variables like energy import, energy export, and economic development have been explored during the course of this study as indicators of environmental quality. It bears to note that there are additional factors that have a potentially significant impact on the country's environmental quality which have not been discussed in this study. These unexplored factors should be addressed by scholars in the future in order to generate more valid and accurate findings. Secondly, the quantitative data collected by the author of this study only pertains to ASEAN countries and economies. This data may not be generalizable other developed economies as the ASEAN countries have particular economic and geographical conditions which are unique. Future researchers should seek to analyze the atmosphere in other countries in order to make the research outcomes of this study more generalizable and universal

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