Nexus between Economic Growth and Environmental Degradation in ASEAN-10 Countries

Abstract

The linkage between GDP growth and CO2 emissions is studied in this research among the ASEAN-10 countries, as for the gradual economic growth received by the ASEAN economy; we need to analyze the complex and nonlinear relationship between the environmental indicator CO2 and economic growth. In recent decades, ASEAN countries have passed through a period of rapid economic development associated with industrialisation, urbanisation and increasing foreign direct investment. But this growth has entailed a heavy environmental cost — soaring carbon emissions, deforestation, pollution.By using econometric methods, such as Granger causality and Johansen cointegration tests, this study investigates the short-term and long-term relationship between Economic Growth and Environmental Degradation across ASEAN 10 countries from 1990 to 2023.The results show notable country-specific economic-environmental relationships. Countries such as Cambodia and Philippines, on the other hand, demonstrate this strong causality where GDP growth causes emissions to increase, which implies the presence of energy-intensive industries and weak regulatory frameworks. In contrast, we see severe growth in countries such as Singapore, which has invested in renewable energy and tough environmental policies. Therein, the study reflects the importance of renewable energy, technology innovation and regional cooperation in sustainable development.Besides advocating for green growth strategyacrossASEAN,the analysis makes it evident that the need for the involvements of customized policies are required to address the distinctive national challenges.These recommendations include expanding the adoption of renewable energy technologies, implementing more stringent environmental regulations, and encouraging global collaboration.

Keywords: Economic Growth, EnvironmentalDegradation, Renewable Energy Consumption, environmental sustainability, ASEAN-10

JEL classification: O44, Q53, Q42

1. Introduction

The ASEAN policy makers have always valued economic development as the focus and goal [1]. However, a lot of negative impact has been placed on the environment due to this fast rate of economic development and the area of focus is having a number of problems within the environmental department, such as deforestation, loss of bio-diversity and contamination of air as well as water. The ASEAN nations have experienced remarkable rates of economic growth for the past few decades; during the 1990s, the Gross Domestic Product has grown at a rate higher than 5% per annum[2]. This economic expansion is as a result of many factors such as; urbanization, industrialization and increased FDI flows.

Still, economic growth has been made at the cost of environment which is necessary to improve standards of living and fight poverty. Several countries have had the probability between carbon emissions and economic growth analysed. Because CO2 emissions per capita are the largest source of pollution, they are used most frequently as the pollutant, with the main parameter being GDP per capita.

One of the greenhouse gases, carbon dioxide, has risen due to the region's power-hungry manufacturing, fast growing urbanization, and expanding transportation sector.

People and their well-being are endangered by pollution, to a greater extent. As the WHO investigations indicate, prolonged exposure to air pollution was estimated to have caused 7 million deaths globally. These comprise of deaths that result from contact with hazardous substances and allergens in the environment and in homes (National Institute of Environmental Health Sciences).[3]

Bearing these facts in mind some properties concerning the correlation between the variables may vary depending on the certain country groups including G20, BRICS, ASEAN, MENA, OPEC, G7 and others. In this case, the different results might be attributed to the nation's location, type of industries, and whether the industries are industrial, service or agricultural based. It is assumed that if the service sector dominates in a particular country, such a country can become a developed market with relatively low pollution level irrespective of the degree of development of the country, whether it is underdeveloped, developed or is in process of development. In addition, it is realized that the outcomes also vary depending on the type of subjects: for example, if a national analysis was made, then the results might be different

from the results of a regional analysis. This means that various countries need to make and adopt different polices and regulatory techniques concerning their emission problems and for the growth that is sustainable since the outcomes are different. Thus, emission reduction is a more challenging task than it can be thought to be. [4]

The ASEAN countries therefore suffer some serious environmental challenges due to poor environmental standards and controls, failure by these countries to enforce pollution control laws, poor funding in environmentally friendly technologies and energy sources.

The governments of the ASEAN have struggles to address the issue of economic growth and environmental concerns because of the connection between the deterioration of the environment and economic growth. Commendably, a vast number of governments in the region have implemented policies and programmes to regulate emission, protect resources, and foster sustainable development hence they understand the imperative of environmental problems. [1]

Thus, efforts to elaborate corresponding links between deterioration of the environment and economic growth in the ASEAN area require more efforts and coherence. It implies that sustainable economic development strategies for the local population, and for the protection of the local natural resources of the region, should comprise the balance of the two commodities.

This research seeks to establish the extent to which economic growth has contributed towards environment degradation in ASEAN-10 countries. It considers how these emissions impact the environment and assesses whether such nations are transitioning to sustainable development or whether environmental detriment continues to result from their efforts to propel their economies. This research seeks to contribute to the general discourse on how developing countries might assume responsibility for environmental degradation while attaining economic growth using historical events and present trends in analysis.

2. Review of Literature

Many scholars have gone deeper to look at the interaction between carbon emission and economic activity on the quality of environment hence the issue of environmental degradation and economic growth in ASEAN-10 countries is complex and needs more research. A study conducted in 2022, analysed the determinants of carbon emissions in ten

ASEAN countries. To analyse the Interactions between carbon emissions from 2010 to 2018 and GDP size, population, and industrial growth. These factors accounted for 99% of the variability in emissions, which the results showed, confirmed by the fixed-effect model. This implies that, for industrial expansion to take place and be sustainable, the adverse environmental impacts that such development ought to trigger call for sustainable growth strategies.[5]

In a study on urban population and CO2 emissions on GDP per capita, there was comparison among urbanization, CO2 emissions, and GDP per capita from 1995 to 2021. It was able to conclude that while for middle-income country both urban and emissions are mainly behind the economic growth showing the significance of the differentiated approach to the sustainable development [6]. Analysing the consequences of economic freedom across seven ASEAN countries, and the causal relationship between economic freedom and CO2 emissions, it was assumed that increased economic freedom reduces CO2 emissions. This was confirmed and the report highlighted the significance of putting into consideration environmental issues to do with more economic planning for economic empowerments and the application of information and communications technology for environmental conservation [7].

A more elaborate regional approach was used in the study, “Towards a Low Carbon ASEAN”, which assessed how the ASEAN countries could cut emissions synergistically using the MRIO model. Using the parameters from the MRIO model, the authors found that emission reductions depend on the level of economic development and technical progress; they also proposed further development of the MRIO model to achieve a better balance in GDP growth and emissions[8]. In the same similar way, Lean and Smyth [9] estimated the co-integration and long-run causality nexus of CO2 emissions, electricity consumption and output in ASEAN. Their empirical evidence was in line with the Environmental Kuznets Curve (EKC) hypothesis that social environmental quality is inversely related to economic growth in the early stages and directly related later. Further, the study suggested the analysis of the relationship energy-economy-environment on the sectoral level for a better understanding.

While analysing the impact of tourism, trade openness, FDI and renewable energy consumption on CO2 emissions in the six ASEAN countries under the Kaya’s Identity of Energy (EKC) hypothesis, it was found that income level had a moderating influence while trade openness factor showed a direct relationship with emissions while tourism and foreign

direct investment showed a positive relationship with emissions. Some suggestions for better use of renewables and less dependence on fossils were developed after it was found out that despite the renewable energy reducing emission in the short run, this had no similar effect in long run especially in economies that rely on tourism [10]. A related idea surfaced in the study of "Economic Growth and CO2 Emission in ASEAN: Panel-ARDL model approach",which found out that there is a long run and short run relationship between GDP and CO2 emissions. This way the study encouraged the spread of green growth policies, and investment in renewable energy sources to enable economic development to be separated from the negative impact on the environment [11].

Based on the research in the article "Does Growth has impact on CO2 Emission in ASEAN Countries"? ,the analysis showed that CO2 emissions are significantly affected by GDP per capita but not much by the population and HDI. To this, it pointed out that environmental sustainability could only be achieved by utilizing renewable sources of energy besides educating the people [12]. In an attempt to test the EKC hypothesis, Gillani and Sultana [13] worked on the title; "Empirical relationship between economic growth, energy consumption and CO2 emissions", on nine ASEAN countries from 1970 to 2019. It found out that energy use put up emission levels tremendously but emissions reduce with the improvement of economic growth hence the call for polices on renewable energy and efficiency.

Another study was done by Adrian et al, [14] in the context of their study "Analysis of Increasing CO2 Emissions and Economic Activity in Four ASEAN Countries" which focused on the effects of the GDP, population, deforestation and energy consumption on emission levels. They identified that these emissions were mainly due to Factors like GDP and energy consumption. Therefore, in seeking to enhance the practice of econometric analysis, the present study suggested that more time should be spent on research and more countries should be worked on. Cross-sectional dependence was also required in econometric modelling by

The article "CO2 Emission, Energy Consumption and Economic Growth in ASEAN-5 Countries" which found significant differences in how GDP and energy consumption influence CO2 emissions in these countries. The study recommended that in order to regulate environmental impacts, there should be availability and efficiency of energy without having to hinder the economic development of nation states.[15]

As for the energy consumption and FDI, the study "The Dynamic Linkages between CO2 Emissions, Energy Consumption, and Economic Factors in ASEAN Countries", analysed the

long-term co-integrated relationships between energy consumption, CO2 emission and the economic factors which are FDI. It unveiled that FDI and economic crises are dissimilar though both enlarge emissions proportional to energy consumption and economic development. Specific recommendations provided in the report included use of renewable energy resources, putting in place laws for the use of sustainable energy and encouraging technology advancement in the pursuit of economic growth without depleting the environment in ASEAN countries [16]. Another study, namely "The Role of Renewable Energy in the Energy-Growth-Emission Nexus in ASEAN", also revisited the EKC hypothesis for ASEAN nations, where we identified a negative association between carbon emissions and renewable energy but a positive relationship between emissions and energy consumption. In the report, ASEAN authorities were recommended to increase the share of renewable energy sources in the development of the competent energy sources where the need for renewable energy was stressed as an important factor in achieving economic growth along with decreasing CO2 emissions [17].

Taken collectively, these studies underscore a complex link between environment degradation and economic development in ASEAN-10 countries. By highlighting impacts of economic activities such as urbanization, Industrialization and energy use, the results depict how renewable energy and economic freedom can influence these carbon emission impacts. The proposals suggest a better deployment of renewable energy, green growth approaches, and technical solutions for the countries in the region in its effort to strike a workable balance between environmental conservation and economic growth.

3. Objectives

The objectives of the research paper are as follows:

Firstly, to analyse the causal relationship between economic growth (GDP) and CO2 emissions among ASEAN-10 countries using Granger causality test. Secondly, to assess the long-term relationship between economic growth (GDP) and CO2 emissions among ASEAN-10 countries employing Johansen's cointegration Test.

4. Methodology and Data Source

4.1 Methodology:

The econometric techniques used to analyse the relationship between economic growth and environmental degradation are:

While working with time series data and for performing co-integration tests, we need to determine the stationarity of the data or degree of integration, *I(d)*. We will use Augmented-Dicky-Fuller(ADF) Unit Root Test [18] for this purpose [19].

Granger Causality Test is a statistical hypothesis test to check if there is a directional relationship of GDP with CO2 emissions. This test, which waspropose by Eagle and Granger (1989), analyses whether economic growth leads to environment degradation or vice versa [3],[4].

Johansen Cointegration Test implements the long-run cointegrating relationships between the model variables, GDP and CO2 emissions. The Trace and Maximum Eigenvalue statistics are used to establish the number of cointegrating equations[19].

The analysis focuses on ten ASEAN countries: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. These countries were selected to capture diverse economic structures, policy frameworks, and stages of development within the region. The current study integrates these methods to deliver a more multidimensional understanding of the relationship between economic growth and environmental degradation and provide insight into the way ASEAN countries can gain sustainable development.

4.2 Data Source and Variables:

This paper examines the relationship between economic growth and environmental degradation in the ASEAN-10 countries. It uses variables such as Gross Domestic Product(GDP), CO2 emissions (CO2E) and energy consumption, renewable energy adoption rates and levels of industrialization. These variables depict the interplay of growth and environmental implications. All data is collected from well-established source such as the World Bank Development Indicators (WDI) and comprises panel time-series data collected yearly from 1990 to 2023 for ASEAN-10 countries.

5. Analysis of Results and Discussion

The result of the analysis is present in this section.

Table 1: Result of Granger Causality test for ASEAN 10 countries

Countries	Null Hypothesis	F-Static	Prob.
Brunei Darussalam	GDP does not Granger Cause CO2E	1.09	0.35
	CO2E does not Granger Cause GDP	2.45	0.11
Cambodia	GDP does not Granger Cause CO2E	10.06	0.00
	CO2E does not Granger Cause GDP	0.74	0.49
Indonesia	GDP does not Granger Cause CO2E	2.84	0.08
	CO2E does not Granger Cause GDP	0.07	0.93
Malaysia	GDP does not Granger Cause CO2E	2.45	0.11
	CO2E does not Granger Cause GDP	3.42	0.05
Philippines	GDP does not Granger Cause CO2E	4.17	0.03

	CO2E does not Granger Cause GDP	0.06	0.94
Singapore	GDP does not Granger Cause CO2E	1.03	0.37
	CO2E does not Granger Cause GDP	4.3	0.02
Thailand	GDP does not Granger Cause CO2E	0.79	0.47
	CO2E does not Granger Cause GDP	6.41	0.01
Vietnam	GDP does not Granger Cause CO2E	1.61	0.22
	CO2E does not Granger Cause GDP	1.49	0.24
Lao PDR	GDP does not Granger Cause CO2E	2.51	0.09
	CO2E does not Granger Cause GDP	18.48	9.00
Myanmar	GDP does not Granger Cause CO2E	3.41	0.05
	CO2E does not Granger Cause GDP	0.37	0.69

Source: Author's calculation

Table 1 shows the Granger causality analysis, which reveals different trends among the ASEAN-10 countries. It has been concluded that in such countries as Myanmar, Cambodia, and the Philippines, GDP Granger-causes CO2 emissions, which means that growth in such states is highly dependent on industrial development and fossil fuel consumption. This implies rapid urbanization and industrial development, which have caused deterioration in the

environment, leading to a lack of sustainable methods. Contrarily, Singapore and Vietnam have no evident causality between GDP and CO2 emissions, which shows that these economies could have decoupled their economic growth from environmental damage. This may have been because these economies were willing to invest in modern technologies and activate potent environmental legislations. An interesting finding is that of Thailand, which has reverse causality wherein CO2 emissions directly impact GDP. This indicates that environmental degradation can be an inhibitive factor to economic productivity for a long time and thus suggests the importance of mitigating pollution to ensure continued economic growth.

Table 2: Result of Cointegration test for ASEAN 10 countries

Countries	Hypothesized No. of CE(s)	None	At most 1
Brunei Darussalam	Trace Statistic	13.34	2.798
	Prob.	0.103	0.094
Cambodia	Trace Statistic	19.18	4.276
	Prob.	0.013	0.039
Indonesia	Trace Statistic	6.077	0.042
	Prob.	0.686	0.838
Malaysia	Trace Statistic	11.03	0.62
	Prob.	0.209	0.431
Philippines	Trace Statistic	8.901	0.125
	Prob.	0.375	0.723
Singapore	Trace Statistic	12.32	0.049
	Prob.	0.142	0.825
Thailand	Trace Statistic	11.2	1.485
	Prob.	0.199	0.223
Vietnam	Trace Statistic	8.771	1.289
	Prob.	0.387	0.256
Lao PDR	Trace Statistic	8.901	0.125
	Prob.	0.375	0.723
Myanmar	Trace Statistic	8.497	1.026
	Prob.	0.414	0.311

Source: Author’s calculation

Table 2 shows the analysis of cointegration which provides additional insight into the long-run relationship between economic growth and environmentally degenerative practices. The trace statistics show that for most of the countries in ASEAN, for example, Brunei Darussalam and Indonesia, there is a weak or, in some cases, non-existent long-run relationship, and short-term economic variables appear to dominate concerns with sustainability issues. Cambodia, however, shows evidence of a long-run relationship connecting the nation's GDP and CO2 emissions. This finding indicates that the economic activities in this nation have a strong impact on environmental quality, thereby creating an

urgent need for sustainable strategies that are integrated into its plans for development.Such a study points out significant variations in how different countries in varying stages of development approach the growth-environment nexus. For example, high-growth economies like Singapore and Malaysia display relatively better capacity to mitigate CO2 emissions while sustaining economic growth. Such countries have invested heavily in renewable energy and energy-efficient technologies and have, therefore, seen the benefits of balancing their economic and environmental priorities. In contrast, the more underdeveloped nations such as Lao PDR and Cambodia tend to be more dependent on non-renewable forms of energy and have insufficient implementation of environmental regulations and hence reflect a stronger association between economic activities and deterioration in environmental quality. For resource-dependent nations like Indonesia and Myanmar, the figures reveal that energy-intensive industrial and extraction industries contribute highly to emissions. Due to this, there is, then, the need for tailored interventions with advocacy of clean energy and structural changes in regulations.

6. Conclusion

Granger causality analysis in Table 1 indicates variations across ASEAN-10 nations. GDP Granger-causes CO2 emissions in Myanmar, Cambodia, and the Philippines, so growth depends on industrial development and fossil fuel consumption. This indicates increasing urbanisation and industrial growth, which have degraded the environment and prevented sustainable approaches. Singapore and Vietnam have no apparent correlation between GDP and CO2 emissions, suggesting they may have decoupled economic expansion from environmental harm. This may have been because these economies invested in new technology and passed strong environmental laws. Thailand's reverse causation between CO2 emissions and GDP is intriguing. This demonstrates that pollution mitigation is necessary to sustain economic development since environmental deterioration may slow economic growth for a long period.

Table 2 displays cointegration analysis, which illuminates the long-term link between economic expansion and environmental degradation. The trace data suggest that most ASEAN nations, including Brunei Darussalam and Indonesia, have a poor or non-existent long-term connection, and short-term economic factors dominate sustainability concerns. Cambodia reveals a long-term link between GDP and CO2 emissions. This shows that this nation's economic activities have a major influence on environmental quality, highlighting the necessity for sustainable development measures.

To summarize, this paper has shown that ASEAN-10 countries must take an integrated approach towards development rather than a traditional approach. There is also an economic-environmental connection which we present in their papers and voicing their stance in which immediate feedback, profit or growth is not the only concern for countries, but rather, it is a component among others that drives long-term sustainable growth. For this, innovation, international collaboration, and integration of environmental issues at national and regional levels are necessary. There is evidence however that in the case of ASEAN nations, a common approach may not be appropriate given their varying degrees of development. Instead, specific weaknesses of every country both economically and environmentally will be the defining criterion for corrective measures. This transformation involves promoting clean energy technologies, setting stricter regulatory frameworks, and advancing innovation for a stronger ASEAN economy. This paper adds new dimensions to existing practices by focusing on the factors where development does not only depend on focus for GDP but rather how fair, how inclusive and how sustainable the future outlook is for coming generations.

7. Policy Recommendations

The results highlight the need for distinct policy strategies suited to the specific circumstances of each ASEAN country. High-growth economies should focus on scaling up adoption of renewables and increasing technological innovation to continue decoupling growth from emissions. Developing countries must be supported with funding and the development of institutional capacities to allow for the adoption of green technology. Upon natural-resource-dependent countries with cleaner-energy alternatives bought on the cheap, fossil fuels could have to take a back seat, but such legislation can't come at the sacrifice of economic development. Across the region, the path to sustainable economic growth lies in stricter environmental regulations, the promotion of green investments, and regional cooperation.

8. Limitation

This study uses mainly GDP and CO2 emissions as variables for the drivers of economic growth and environmental degradation, which might not capture all the relevant dimensions of the sustainable development challenge. This narrow view might overlook crucial aspects of the challenge, such as energy efficiency, sector-specific contributions to emissions, or broader implications of climate resilience. To increase the depth and relevance of future research, additional variables should be incorporated that offer more refined insights into the

nexus between growth and the environment. Variables such as energy efficiency indices, renewable energy adoption rates, sector-specific impacts, and climate resilience measures could greatly broaden the scope of analysis. These factors can be integrated into future studies, thus providing a more holistic view that can help policymakers devise strategies to maintainstability between economic growths with environmental sustainability.

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