



## An unexplored Nexus of Political freedom, Economic Growth, Economic conditions and CO2 emission in Asian Country

Naveed Jan, Muhammad Rizwan

### Chronicle

#### Article history

**Received:** Oct 14, 2023

**Received in the revised format:** Dec 06, 2023

**Accepted:** Dec 20, 2023

**Available online:** Dec 25, 2023

**Naveed Jan** is currently affiliated with Shandong Normal University Jinan, China.

Email: [needo@yahoo.com](mailto:needo@yahoo.com)

**Muhammad Rizwan** is currently affiliated with PhD Scholar Universiti Utara Malaysia (UUM), Malaysia.

Email:

[rizwan.bwp22@yahoo.com](mailto:rizwan.bwp22@yahoo.com)

### Abstract

The forefront of global leadership agendas emphasizes the promotion of sustainable environmental development. Humanity grapples with a significant challenge posed by a worldwide environmental issue. Political institutions in every nation bear the responsibility of crafting and executing policy agendas. This study aims to scrutinize the intricate interplay between the existing state of political institutions, environmental emissions, and development indicators. Notably, it delves into the nuanced impact of diverse economic conditions, encompassing a free economy, a fluctuating economy, a degraded economy, and an improved economy. Over the course of twenty-four years, from 1998 to 2021, information for this study was collected from ten different ASEAN nations. The panel data methodology is utilized in order to answer the research question. Estimates that account for fixed effects indicate that there is a significant positive correlation between economic growth and CO2 emissions. It is also evident that CO2 emission levels are higher in Asean economies that are more volatile, such as Indonesia and Thailand, while they are lower in economies that have improved, such as Singapore. This study represents one of the pioneering investigations on the subject at hand. The insights derived from this research are poised to serve as a valuable guide for the implementation of environmental policies.

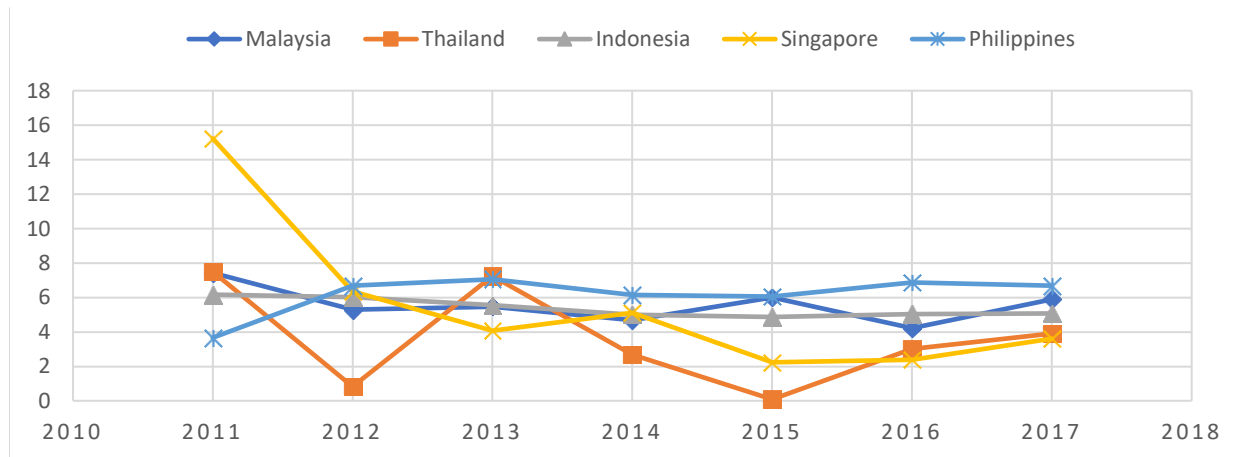
**Keywords:** COVID-19, Stock Market liquidity, Stringency Index, Confirmed Cases Death Case, Pakistan

© 2022 Asian Academy of Business and social science research Ltd. All rights reserved

## INTRODUCTION

The Environmental Kuznets Curve hypothesis posits that during the process of economic development, a country's emissions into the environment initially increase, leading to environmental degradation. However, once a certain level of economic development is reached, emissions decrease, contributing to environmental restoration (Özokcu & Özdemir, 2017). This gives rise to an inverted U-shaped curve known as the income-emission curve. Several factors contribute to this hypothesis, including shifts in the national income structure during economic development, transitioning from agriculture to industrialization and services (Balsalobre-Lorente et al., 2018). Industrial emissions tend to decrease after reaching a certain threshold. Technological advancements also play a role in achieving a more environmentally friendly Earth. As individuals experience an

increase in per capita income, there is a growing demand for environmental quality. Additionally, political institutions contribute to the fulfillment of national and global environmental objectives. This paper endeavors to empirically investigate the relationships between environmental degradation, democracy, urbanization, and economic development.



**Figure.**  
**Economic Growth in Asean Countries**  
**Source: World Bank**

The economic turbulence in Asean country is visible from figure as the overall in Asean region economic growth is on decline. Meanwhile, in Thailand the economic growth is highly turbulent (see figure 1). The relation among income and environmental quality does not take place without considering the impact of government policies (Balsalobre-Lorente et al., 2018). Political institutions control the environmental strategic instruments to ensure environmental quality. Several researchers and policy analysts have also argued about this phenomenon. Mixed empirical evidence is found in terms of EKC hypothesis (Bailey, 2017). The difference in the empirical findings by researchers is due to the difference in the sample size, method employed, and the constructed model for the estimation of association among the control variables added into the model. Carbon dioxide is a main constituent of greenhouse gases and is one of the major contributors of environmental degradation, which is emitted as a result of several human activities. Carbon naturally circulates around the soil, animals, plants, and atmosphere. So, basically carbon dioxide is a natural part of the ecosystem and Earth's carbon cycle.

Therefore, human activities are responsible for changes that occur in the Earth's carbon cycle. Various human activities emit carbon dioxide in the form of burning fossil fuels to get oil, natural gas, and coal for transportation and energy purposes. Land use and industrial processes also influence the carbon cycle. It has been argued that CO<sub>2</sub> causes a considerable impact on global level than on local level (Bhattacharya et al., 2017). It is not easy to comprehend the complex relationship that exists between a thriving economy, rising carbon emissions, and unfettered political liberty. The relationship between a person's income and the natural world is a complicated one, and political institutions have a substantial impact on how it develops. The expansion of people's rights to access information and exercise political power has directly resulted in increased

environmental regulation as well as heightened awareness among the general public (Oraby et al. 2018). Especially in democracies, environmental interest groups can be an asset in the effort to raise more awareness. In contrast to democracies that place a greater emphasis on public participation, autocratic regimes make decisions on their own and stifle free speech and information. Because representatives are required to hold themselves accountable, citizens can have confidence that the government will take their concerns into consideration when making decisions (Zhou et al., 2019). If you live in a democracy, your national government will stand behind free markets and the economic independence of individuals. If the democratic government follows through on the things it says it will do and obeys the laws governing the environment, then we can anticipate an improvement in the state of the environment. One of the economic conditions is referred to as "economic freedom," and it incorporates all of the sub-indicators, such as the presence or absence of government intervention in the market, as well as other conditions. Information pertaining to the top five ASEAN member states is presented in Table 1.

**Table 1.****Economic freedom Index**

| Country    | Score |
|------------|-------|
| Singapore  | 8.84  |
| Philippine | 7.34  |
| Indonesia  | 7.16  |
| Malaysia   | 6.92  |
| Thailand   | 8.85  |

**Source.****Fraser Institute**

The relationship among environmental degradation and income was presented through a seminal paper by (Rafiq et al. 2016). They argued that initially in the way of development, the environment starts deteriorating but after reaching a certain level of income per capita, the environmental quality starts to improve. The turning point is different for different countries (Ouyang & Lin 2017). Therefore, a turning point of \$8000 is set for most economies. All aspects of environmental quality including water and air quality are also observed. They employed panel data and incorporated short equations for the estimation of the model (Zhang et al. 2018). They presented an inverted U-shaped with negatively sloped curve and defined it as Environmental Kuznets curve. Afterwards, numerous researchers have reanalyzed the EKC hypothesis. The paper primarily focuses upon theoretical literature and empirical evidence about EKC hypothesis, later a second collection of literature is considered regarding the impact of democracy on the connection between emission and environment.

## LITERATURE REVIEW

In this regard, meta-analysis can provide a clearer picture of a huge literature. A meta-analysis was conducted by (Wehkamp et al. 2018) including 69 research studies with 547 regressions, to observe for the variations in the outcomes of EKC hypothesis, taking deforestation as an indicator of environmental degradation. The results have shown that more advanced research results in the higher probability of rejecting EKC hypothesis. The results deduced from the study exhibited that the selection of control variables

significantly affect the probability of occurring an EKC association. Trade has negatively influenced the likelihood of obtaining EKC for deforestation. It is declared that trade being a control variable have diverted the transmission of environmental degradation and macro variables. The underlying finding have provided researchers with a potential direction for future research regarding EKC hypothesis.

Many researchers have explored the theoretical dimensions of EKC hypothesis. Theoretical dimensions of EKC model have also been observed by (Choumert et al. 2013). The dynamic and static feature of classification was adopted between various classifications about EKC debate. They concluded that several researchers do not agree upon this hypothesis, while some of the researchers were found to be doubtful regarding the application of used methodology and data for the purpose of explaining EKC curve. A few basic econometric problems of traditional EKC estimation methods were highlighted by (Heidari, Katircioğlu et al. 2015) and also suggested alternative methods of estimation. In addition, he proposed a between estimator for dealing with the time effect issues and cross-sectional dependency. It is also highlighted that time-dummies do not take into account the technological variation related to time, which could result in the simultaneous association among country effects and regressors as well as with the residual terms.

Econometric issues that occur while testing EKC hypothesis were inspected, incorporating data from 132 economies during 1992-1994. Carbon dioxide that is emitted from the combustion of fuel was employed. Cross-sectional regression was performed using simple t-test and panel data set for each year, in order to test the EKC hypothesis (Charfeddine & Mrabet 2017). The remarkable change in financial sector during the process of economic development has gained attention from the analysts and researchers. The increasing literature on EKC also fell out for some unique outcomes of EKC hypothesis. An empirical analysis was conducted ((Tiba & Omri 2017) to inspect the effect of economic growth and financial development on the worsening of environmental quality. Data was taken for BRIC countries i.e. Brazil, Russia, India, and China, for the years 1980-2007. The technique employed for the analysis of panel data is panel cointegration, and the findings obtained from the analysis supported the EKC hypothesis. Results have shown that for a given level of GDP, CO<sub>2</sub> emission for FDI is inelastic, for GDP it is elastic, while for energy consumption it is also elastic. Thus, indicating that high elasticities show high responsiveness, that is the variations in the consumption of energy and its output highly affects the environmental quality but have no direct impact on the FDI (Charfeddine & Mrabet 2017).

Researchers have seek to investigate the effects of trade openness, urbanization, energy consumption, financial development, and GDP on Environmental Kuznets Curve. Environmental Kuznets curve has been explored through a country's ecological footprints, and data was taken from 93 countries during 1980-2008 (Al-Mulali et al. 2015). Other than financial development and GDP, trade openness, urbanization, and energy consumption were selected as the explanatory variables. The cross-sectional data for the study was also divided into high-income, upper-middle income, lower-middle income, and low-income economies and discovered that Environmental Kuznets Curve hypothesis is only applicable for high-income and upper-middle income economies and not for lower-middle and low-income economies. Results are obtained through performing generalized method of moments and fixed effect model.

A few researchers who suspect about the methods of testing EKC hypothesis, have also proposed tipping band for considering the appropriate policy instruments. Another study has re-assessed the EKC hypothesis and suggested a tipping band that is appropriate for the policymakers to use, particularly for those who are concerned about EKC (Al-Mulali & Ozturk 2016). Three control variables namely number of CO<sub>2</sub> in kgs, per kg of oil, that is equivalent of energy, proportion of energy that a country utilizes from fossil fuels, and industrial share in GDP. Data for SO<sub>2</sub> and CO<sub>2</sub> was collected for 114 economies during the time period 1960-2007. (Al-Mulali & Ozturk 2016) declared that it is quite uncertain and difficult to identify the economically feasible tipping point through utilizing the non-parametric spline based alternative and parametric baseline.

Mixed results are found in the literature regarding democracy's impact on EKC. A group of researchers have claimed that democracy brings improvement in the quality of environment while the other group argued that political institutions are responsible for the deterioration of environmental quality (Nguyen et al. 2018). A third group is the one who have further argued that there is no direct influence of democracy on environmental quality. A study was conducted to empirically examine the democracy-environment relationship, through emphasizing impact of the type of political system on the human activities which are responsible for environmental degradation (Edelenbos et al. 2017). They incorporated five human activities that deteriorates environmental quality, such as deforestation, organic water pollution, nitrogen oxide & carbon dioxide emissions, and land degradation (Salahodjaev, 2018). The study used data for 105 economies with 143 variables approximately. Population density, trade openness, GDP per capita squared and GDP per capita were added into the model as control variables, while democracy is taken as a dichotomous and continuous variable (Obydenkova and Salahodjaev 2016).

The findings of the study indicated that democracy helps in reducing environmental degradation, while the effects may vary with the change of environmental indicators. Reduction of human based activities improve environmental quality as these activities are directly associated with the degradation of environment (Clulow, 2019). Polity IV is not a sole index as an indicator for democracy. It is interesting to observe how outcomes change with the change in indicators (Escher & Walter-Rogg 2018). EKC hypothesis was revisited by taking Civil Liberties index, Freedom Political rights index and Polity II as the indicators of democracy for examining the impact of trade openness and democracy (Siakwah, 2018). This issue was examined through applying quantile regression techniques on cross-sectional data of countries during 1985-2005.

Furthermore, to explore the demographic and economic structure of economies, three variables that are likely to affect pollution i.e. industry's share in GDP, population size, and trade openness are integrated into the model (Galarraga et al. 2016). Where, trade openness is computed as the ratio of annual exports plus imports against GDP, and total population in a country is taken as the population size. The democracy's impact on CO<sub>2</sub> emissions was found to be heterogeneous across different quantiles. Emissions tend to reduce with greater democracy in most countries with higher levels of emissions, although it does not likely to reduce with better financial openness (Jabeur & Sghaier 2018).

Empirical analysis performed on Environmental Kuznets Curve is greatly affected by the selection of sample size. Sample data from 141 developing countries was collected to investigate the association among environmental quality and democracy during the years 1976-2003 (Mak-Arvin & Lew 2011). They incorporated deforestation, water pollution emissions, and CO<sub>2</sub> emissions as the measures to determine environmental qualities. Quality ratings for Civil liberties and political rights that relies on the detailed examination of lower values and country situations, exhibit freer societies to be the indicator of freedom. In addition to GDP per capita, population per square kilometer and urban population as a percent of total population were added in the model(Wangler & Al Doyaili-Wangler 2017). The Generalized least square method was employed with a fixed effect per year and country. The study inspected that democracy is beneficial for the improvement of environment(Böhmelt & Butkutė 2018). The level of improvement differs depending on the standard that is used for estimating quality of environment. These variations do not appear to be uniform, rather remarkable across different sub-units. However, the study found no consistent correlation among the state of environment and democracy(Spilker & Koubi 2016).

It has been put forward that democratic system and the freedom associated with it, allow individuals to consider and exercise their environmental quality preferences more efficiently during autocratic government. Polity IV project, a quantitative research program on political institutions has employed. Polity IV dataset plus ten is considered as independent variable, refers to the political government, where increase in its values explains greater freedom in democratic regime among nations and over time (Li et al., 2016). The hypothesis for their study was supported by the empirical findings i.e. environmental quality is positively affected by democracy. The study concluded that interaction of certain attributes of political regime and societal preference indicators construct an inverted U-shaped EKC.

Democracy's impact on EKC can also be affected through other factors such as, land area, control of corruption, rural population, income, and education. Researchers have been interested to consider the ability of income to explain environmental degradation as compared to democracy. In addition to income level as an indicator of economic development to observe the income-emission nexus, democracy index as a political development indicator and other independent variables are added into the model for assessing the broadening scope of EKC (You et al. 2015). They incorporated variables namely; income, control of corruption, rural population, and land area to observe their impact on deforestation rate i.e. average annual rate of change in forest. The data for 177 countries was taken for the time period 1990-2000.

The level of democracy is taken from the Polity index as a primary explanatory variable. The measure ranges from -10 to 10, where -10 indicates autocratic system while 10 indicates democratic system. A U-shaped association has been found between democracy and deforestation. Comparing the mature democratic countries and non-democratic countries, highest rate of deforestation is witnessed under democratic countries. In addition, democracy largely explains the deforestation rate as compared to income. Thus, emphasis should be on democratization instead of economic development in order to reduce the rate of deforestation. Distributional income equality is not likely to be guaranteed at initial stage of economic development. However, EKC hypothesis can also be influenced with persistent levels of income inequality. The relation



among political strength of most environmental good consumers, economic development, income inequality, and environmental degradation was investigated (Shafik & Bandyopadhyay 1992). It was declared that environmental quality has varied impacts of democracy, which depends on the effects of income and price on the environmental goods demand. He concluded with the presumption that, there are two categories of individuals in the society having different thinking and levels of pollution exposure. Furthermore, he assumed that decisive voter is likely to come from the exposed group, while the autocrat does not belong to this class. Thus, democratization is found to be favorable for the healthy environment indicating that the more beneficial impacts on environmental development the greater the contrast among the two politically decisive actors. Some other researchers have argued that existence of this inequality negatively affects the environmental quality, although indirectly, which results in the equalization of democracy's impact on environmental quality.

The transmission channel of democratic institutions influence on environmental quality has been examined, using two indicators of environmental quality for 122 countries, during 1960-2008 (Shafik & Bandyopadhyay 1992). The results have shown that environmental quality has opposite effect of democratic institution, that arise from an indirect negative influence on income inequality & investment and positive direct influence on the quality of environment using fixed effect estimators, one-step and two-step GMM-System, and the error terms that are generated from the econometric model. The results of democracy explains that components of democracy can individually cause influence on the analysis. Thus, a few studies have explored the effects of other control variables and democracy elements on environmental pollution.

Through observing a conventional relation among environmental quality and economic growth (Batterbury & Fernando 2006), have presented their doubts regarding this relationship. Air monitoring data was employed for 1986-1999. Per capita income, pollution-intensive economic activity, population density, vulnerability, and governance were taken as explanatory variables. The study exhibited considerable effects of geographic vulnerability and governance on the air pollution in numerous cities of developing country. A country's environmental quality is affected by the history of its political institution. Democratic capital stock has more influence on environmental quality than the current state of democracy (Fredriksson & Neumayer 2013; Basheer et al., 2019). This stock has been explained as an accumulation of social and civic rights that has gained from the historical experience. Besides other variables, Climate Laws, Institution, & Measures Index was employed as a dependent variable. However, economic growth has an ambiguous impact in the environment-democracy association (Obydenkova and Salahodjaev 2016) Moreover, relative power of organized interest, preferences of voters and political will have a key role in the development of EKC hypothesis.

## ECONOMETRIC MODEL

The EKC hypothesis signifies an inverted relationship among per capita emission and per capita income, having U-shaped curve. The functional form of hypothesis is stated as:

$$E_{it} = f(Y_{it}, Z_{it}, F_i, F_t, u_{it}) \dots \dots (1)$$

Where,  $E_{it}$  denotes emissions per capita,  $i$  country while  $t$  denotes year.  $Y_{it}$  represents the income of the country,  $Z_{it}$  represents the control of the set of other variables that can affect the formulation of EKC hypothesis,  $F_t$  represents the cross-sectional influence,  $F_t$  represents the effects of time, and  $\mu_{it}$  represents the disturbance or the residual term of the model.

Keeping in view the income-emission nexus, it is preferred to incorporate quadratic equation with a negative coefficient of squared per capita income and positive coefficient of per capita income. The studies (Bende-Nabende, 2018) have been followed for construction of the empirical model. The fundamental EKC hypothesis is presented in an equation as:

$$E_{it} = \beta_1 + \beta_2 Y_{it} + \beta_3 (Y_{it})^2 + \beta_4 Z_{it} + \mu_{it} \dots (2)$$

To form the quadratic equation, the square of income is incorporated, considering the shape of EKC. Therefore, it is a standard form as presented by (Fredriksson & Neumayer 2013). For the derivation of n-shaped curve, researchers prefer to take cube of the income variable. The tipping point for the model is obtained by taking first order derivative of the constructed equation, which is correlated with,

$$\delta = -\beta_2 / 2\beta_3 \dots (3)$$

Taking log of variables is preferred in order to obtain methodological and computational benefits. In addition, effects of change in elasticity can be easily explained through coefficients. Thus, the model is presented as follows:

$$\ln E_{it} = \beta_1 + \beta_2 \ln Y_{it} + \beta_3 (\ln Y_{it})^2 + \beta_4 Z_{it} + \mu_{it} \dots (4)$$

Per capita CO<sub>2</sub> emission is taken as the variable for environmental emission, which is the dependent variable and also the specific area of interest. Whereas, per capita GDP is taken as the independent variable. However, the basic model only includes emission and income, having no control variables, except GDP. The primary model for this study is defined as:

$$\ln CO_{2it} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 (\ln GDP_{it})^2 + \mu_{it} \dots (5)$$

To observe the structural change, industry-GDP ratio is added as an industry variable in the model. The fundamental EKC hypothesis model is presented as

$$\ln CO_{2it} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 (\ln GDP_{it})^2 + \beta_4 \ln IND_{it} + \mu_{it} \dots (6)$$

Level of democracy is employed as a as a control variable of democracy, for observing the structural change in the country's political institution. The model was finalized as

$$\ln CO_{2it} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 (\ln GDP_{it})^2 + \beta_4 \ln IND_{it} + \beta_5 DEM_{it} + \mu_{it} \dots (7)$$

Thus,  $\ln CO_{2it}$  represents the log of per capita emissions, where  $i$  and  $t$  denotes country and the year,  $\ln GDP_{it}$  represents the log of country's GDP per capita at purchasing power parity,  $\ln IND_{it}$  represents the log of industry to GDP ratio, and  $DEM_{it}$  represents the democracy level of a country. The tipping point is also correlated with

$$\delta = \exp (-\beta_2 / 2\beta_3) \dots (8)$$



Five dummy variables are added into the model for six democracy status categories, then the model is represented as follows:

$$\ln CO2_{it} = \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 (\ln GDP_{it})^2 + \beta_4 \ln IND_{it} + \beta_5 FRDEMi + \beta_6 PRDEMi + \beta_7 IMPDEMi + \beta_8 DETDEMi + \beta_9 FLUCDEMi + \mu_{it} \dots (9)$$

Here the, *FRDEMi* represents the consistently full free economies, *PRDEMi* represents the consistently partly free economies, *IMPDEMi* represents the improved economies who seeks to enhance their level of democracy with time, *DETDEMi* represents the deteriorated economies whose level of democracy is deteriorating over time, and *FLUCDEMi* represents the fluctuated economies who are witnessing fluctuation in their level of democracy over time. Consistently not free economies group is taken as a reference group. The last three models are estimated using different parameters. The tipping points for all the models are correlated with  $\delta = \exp(-\beta_2/2\beta_3)$ . While obtaining the restricted sample and model specifications, consideration of the methodological aspects is also necessary.

The process of transferring political institutions' influence on the income-environment connection is somehow complex and multi-faceted. The panel data set of 10 Asean countries was used for 23-year time-period. This paper aims to empirically explore the role of democracy on the income-pollution relationship. The results found that democracy level as well as consistency of political institution of countries largely influences the tipping point of EKC. Thus, environmental regulation laws and public awareness are the result of freedom of information and political rights. During democratic system, environmental interest groups are encouraged to promote awareness. Social and civic rights that are developed, based on the historical experience helps to maintain responsive and stable environmental policy. Both deviation from perfect democracy to improvement of full democracy causes their multi-faceted impacts on economic structure, policy agenda, capability of countries, and bargaining power of social groups. The result of this research study was not out of the scope of methodological limitations. Keeping in view the limitations of present study, the findings suggested that the effect of political consistency and stability in specific regime on EKC is found to be intuitive. For economies having consistently full democracy, the tipping point occurs at lower levels of GDP per capita, as compared to the economies having full democracy.

## DATA AND METHODOLOGY

The study collected data from ten different ASEAN countries over a twenty-four-year period, beginning in 1998 and continuing until 2021. The panel data methodology will be used to provide an answer to the research question. When it is determined that differences between entities (countries, individuals, etc.) do have an effect on the variable being studied, the random effects model (REM) is used. The RE operates on the assumption that differences between entities are random and unrelated to the predictor variables. In other words, it is assumed that the entity's error term is uncorrelated with the predictor variables, allowing time-invariant variables such as race, culture, and so on to be included as independent variables. This is due to the inclusion of these variables, which allowed the entity's error term to be included. The constant term, on the other hand, takes these variables into account in the FEM model. People who use the REM are expected to specify the characteristics that may or may not influence the predictor

variables. On the other hand, some of the variables may be unavailable, causing the model to be biased as a result of the missing variable (s). We can be thankful that the REM's findings can be extrapolated beyond the model's sample size. The REM model is described as follows:

$$Y_{it} = \beta_{it} \sum_{i=1}^k X_{it} + \mu_{it} + \varepsilon_{it} + \dots (10).$$

The use of panel data has the benefit of controlling for unobserved heterogeneity, which is a distinct advantage. In order to take into account the various time zones and national regulations, equation [11] can be rewritten as follows:

$$Y_{it} = \mu_i + \theta_t + \beta_i \sum_{i=1}^k X_{it} + \varepsilon_{it} + \dots (11).$$

The fix effect method (FEM) takes into account unobservable heterogeneity by permitting the intercept to move in response to changes in both countries and time periods. This method is also known as the "fixed effects" method. Kirkpatrick and Parker (2007) argued that the most appropriate method would be to include a dummy for each country and time in the estimated time-invariant factors that affect the dependent variable. They believed that this would be the most accurate representation of the data. One of the benefits of using a specification known as "fixed effects" is that it gives you the ability to link the effects of particular individuals or times to the variables that are responsible for explaining those effects (Hsiao, 2005). It is possible to use an F-test to determine whether or not to use the pooled OLS estimation technique (restricted model, time, and country effects = 0) or the FEM estimation technique based on the joint significance of the country-specific coefficients in the FEM in comparison to the OLS panel. This decision can be made based on the results of the comparison (unrestricted model). This gives you the ability to choose between the two different estimation methods. The findings of diagnostic tests are presented in a manner that is broken down by both time and cross-sectional unit.

## RESULTS

Table 2 shows the Spearman correlation results for CO2 and other explanatory variables. The correlation between CO2 and IND is strong since the value of the correlation is 0.49, which is close to 0.50 (Cohen, 1988). CO2 and FLUCDEM, on the other hand, have a strong above-average correlation of 0.52 but show negative relationships. Their correlation is significant at the one percent level. Other variables have weak correlations with CO2 since their correlation values are low.

**Table 2.**  
**Correlation**

| Variables | 1           | 2           | 3           | 3           | 4           | 5           | 6           | 7           | 8           |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| CO2       | <b>1.00</b> |             |             |             |             |             |             |             |             |
| GDP       | 0.15        | <b>1.00</b> |             |             |             |             |             |             |             |
| GDP2      | 0.15        | 0.17        | <b>1.00</b> |             |             |             |             |             |             |
| IND       | 0.49        | 0.27        | 0.21        | <b>1.00</b> |             |             |             |             |             |
| FREDM     | 0.15        | 0.09        | 0.10        | 0.17        | <b>1.00</b> |             |             |             |             |
| PRDEM     | 0.16        | 0.20        | 0.05        | 0.21        | 0.01        | <b>1.00</b> |             |             |             |
| MPDEM     | -0.04       | -0.07       | -0.01       | 0.09        | -0.06       | 0.02        | <b>1.00</b> |             |             |
| DETDEM    | -0.02       | 0.04        | 0.10        | 0.04        | 0.01        | 0.21        | -0.06       | <b>1.00</b> |             |
| FLUCDEM   | -0.52       | 0.06        | -0.07       | -0.33       | 0.17        | -0.25       | -0.08       | 0.47        | <b>1.00</b> |

Table 3 displays the results of the regression analysis conducted for this study. Based on the results of the diagnostic tests, it seemed as though the fixed effect method was the most appropriate strategy to apply to this investigation.

**Table 3.**  
**Regression Results**

| Variable               | Coefficient     | Standard Error | t-value | p-value  |
|------------------------|-----------------|----------------|---------|----------|
| Fixed Effects:         |                 |                |         |          |
| Constant               | 52.754          | 2.952          | 17.87   | 0.000*   |
| GDP                    | 0.033           | 0.068          | 3.48    | 0.030**  |
| GDP2                   | 0.508           | 0.773          | 2.66    | 0.012**  |
| IND                    | -2.806          | 0.758          | -3.70   | 0.000*   |
| FREDM                  | 0.178           | 0.046          | 3.88    | 0.000*   |
| PRDEM                  | 0.025           | 0.046          | 0.55    | 0.581    |
| IMPDEM                 | -0.185          | 0.785          | -0.24   | 0.814    |
| DETDEM                 | 0.153           | 0.734          | 2.36    | 0.000*** |
| FLUCDEM                | 0.456           | 0.002          | 2.34    | 0.000*** |
| Diagnostic statistics: |                 |                |         |          |
| R <sup>2</sup>         |                 |                |         |          |
| Within                 | 0.101           |                |         |          |
| Between                | 0.343           |                |         |          |
| Overall                | 0.192           |                |         |          |
| Wald $\chi^2$ (7)      | 24.89           |                |         |          |
| Prob ( $\chi^2$ )      | 0.00            |                |         |          |
| Multicollinearity      | 1.23            |                |         |          |
| Heteroskedasticity     | 5.0e+05         |                |         |          |
| Serial Correlation     | 6.673           |                |         |          |
| F-Statistics           | F(45,360)=23.02 |                |         |          |

The results of the study indicate that there is a statistically significant positive correlation between economic growth and CO2 emissions. In addition, CO2 emissions are higher in economies that are more susceptible to volatility, such as Indonesia's and Thailand's, while they are lower in developed countries, such as Singapore's. The results are in line with what was anticipated.

## CONCLUSION

This study marks a pioneering effort in examining the correlation between ASEAN CO2 emissions and factors such as economic growth, economic conditions, political freedom, and economic freedom. Rooted in the Environmental Kuznets Curve (EKC) hypothesis, it posits that as countries undergo development, they initially contribute to environmental degradation through pollutant emissions. However, as development progresses, nations tend to adopt measures to reduce emissions, leading to a potential decline in environmental degradation—a phenomenon illustrated by the upside-down U-shaped curve on the income-emission graph. This hypothesis is currently being assessed in light of a number of factors. Changes in the composition of a country's national income are one of the factors considered in a nation's progress. As part of their economic transition, the countries are moving toward industrialization and the service sector. Once a certain level of development is reached, the changes begin to contribute to a reduction in emissions.

With each passing day, technological advancements make the world a little greener. As people's incomes rise, so does their expectation that the quality of the environment will rise with them. When national and internal goals are considered, it is clear that the political institution is not yet out of the woods. This study conducts an empirical investigation into the relationship between economic development, democratic government, environmental degradation, and urbanisation spread. The dynamic and complex relationship between rising economic activity, current economic conditions, rising carbon emissions, and democratic governance. The political institutions that govern the two have a complex influence on the relationship between income and the natural environment. Freedom of information and political rights both help to raise public awareness and the government's ability to regulate the environment. Environmental interest groups, particularly within democratic regimes, play a pivotal role in fostering environmental awareness. In such systems, the decision-making process tends to be more inclusive, allowing for a broader flow of information. Democratic governments, responsive to the needs of their constituents, consider various social groups when formulating new policies, as elected officials are accountable to the public. The democratic political structure inherently supports market economies and individual economic freedom, with an expectation that such governments will adhere to the rule of law and environmental legislation, ultimately leading to environmental improvement. The intricate links between income, democracy, and carbon emissions present a complex and challenging understanding. Political institutions impact the transmission process of the environment-income nexus across several dimensions. The development of environmentally friendly policies and increased environmental consciousness among the general public are facilitated by the freedom of information and political rights within a democratic framework. Environmental advocacy groups, operating in a democratic setting, have the ability to effectively raise awareness.

## DECLARATIONS

**Acknowledgement:** We appreciate the generous support from all the supervisors and their different affiliations.

**Funding:** No funding body in the public, private, or nonprofit sectors provided a particular grant for this research.

**Availability of data and material:** In the approach, the data sources for the variables are stated.

**Authors' contributions:** Each author participated equally to the creation of this work.

**Conflicts of Interests:** The authors declare no conflict of interest.

**Consent to Participate:** Yes

**Consent for publication and Ethical approval:** Because this study does not include human or animal data, ethical approval is not required for publication. All authors have given their consent.

## REFERENCES

- Al-Mulali, U., & Ozturk, I. (2016). The investigation of environmental Kuznets curve hypothesis in the advanced economies: the role of energy prices. *Renewable and Sustainable Energy Reviews*, 54, 1622-1631.
- Al-Mulali, U., Saboori, B., & Ozturk, I. (2015). Investigating the environmental Kuznets curve hypothesis in Vietnam. *Energy Policy*, 76, 123-131.

- Bailey, I. (2017). *New environmental policy instruments in the European Union: politics, economics, and the implementation of the packaging waste directive*. Taylor & Francis.
- Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions?. *Energy Policy*, 113, 356-367.
- Basheer, M., Ahmad, A., & Hassan, S. (2019). Impact of economic and financial factors on tax revenue: Evidence from the Middle East countries. *Accounting*, 5(2), 53-60.
- Batterbury, S. P., & Fernando, J. L. (2006). Rescaling governance and the impacts of political and environmental decentralization: an introduction. *World development*, 34(11), 1851-1863.
- Bende-Nabende, A. (2018). *FDI, regionalism, government policy and endogenous growth: a comparative study of the ASEAN-5 economies, with development policy implications for the least developed countries*. Routledge.
- Bhattacharya, M., Churchill, S. A., & Paramati, S. R. (2017). The dynamic impact of renewable energy and institutions on economic output and CO2 emissions across regions. *Renewable Energy*, 111, 157-167.
- Böhmelt, T., & Butkutė, E. (2018). The self-selection of democracies into treaty design: insights from international environmental agreements. *International Environmental Agreements: Politics, Law and Economics*, 18(3), 351-367.
- Charfeddine, L., & Mrabet, Z. (2017). The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries. *Renewable and Sustainable Energy Reviews*, 76, 138-154.
- Choumert, J., Motel, P. C., & Dakpo, H. K. (2013). Is the Environmental Kuznets Curve for deforestation a threatened theory? A meta-analysis of the literature. *Ecological Economics*, 90, 19-28.
- Clulow, Z. (2019). Democracy, electoral systems and emissions: explaining when and why democratization promotes mitigation. *Climate Policy*, 19(2), 244-257.
- Edelenbos, J., Van Buuren, A., Roth, D., & Winnubst, M. (2017). Stakeholder initiatives in flood risk management: exploring the role and impact of bottom-up initiatives in three 'Room for the River' projects in the Netherlands. *Journal of environmental planning and management*, 60(1), 47-66.
- Escher, R., & Walter-Rogg, M. (2018). Does the Conceptualization and Measurement of Democracy Quality Matter in Comparative Climate Policy Research?. *Politics and Governance*, 6(1), 117-144.
- Fredriksson, P. G., & Neumayer, E. (2013). Democracy and climate change policies: Is history important?. *Ecological Economics*, 95, 11-19.
- Galarraga, I., Gonzalez-Eguino, M., & Rübbelke, D. T. (2016). Environmental Economics, Climate Change Policy and Beyond: A Tribute to Anil Markandya. *Environmental and resource economics*, 63(2), 219-224.
- Heidari, H., Katircioğlu, S. T., & Saeidpour, L. (2015). Economic growth, CO2 emissions, and energy consumption in the five ASEAN countries. *International Journal of Electrical Power & Energy Systems*, 64, 785-791.
- Jabeur, S. B., & Sghaier, A. (2018). The relationship between energy, pollution, economic growth and corruption: A Partial Least Squares Structural Equation Modeling (PLS-SEM) approach". *Economics Bulletin*, 38(4), 1927-1946.
- Lau, L. S. (2015). Carbon Dioxide Emission, Institutional Quality, and Economic Performance: A Comparative Analysis Between Developed and Developing Countries Carbon Dioxide Emission, Institutional Quality, and Economic Performance: A Comparative Analysis Between Developed and Developing Countries, UTAR.
- Li, T., Wang, Y., & Zhao, D. (2016). Environmental Kuznets curve in China: new evidence from dynamic panel analysis. *Energy Policy*, 91, 138-147.
- Mak Arvin, B., & Lew, B. (2011). Does democracy affect environmental quality in developing countries?. *Applied economics*, 43(9), 1151-1160.

- Nguyen, C. P., et al. (2018). "The Ambivalent Role of Institutions in the CO2 Emissions: The Case of Emerging Countries." *International Journal of Energy Economics and Policy* 8(5): 7-17.
- Obydenkova, A., & Salahodjaev, R. (2016). Intelligence, democracy, and international environmental commitment. *Environmental research*, 147, 82-88.
- Oraby, T., Bauch, C. T., & Anand, M. (2018). The environmental Kuznets curve fails in a globalized socio-ecological metapopulation: a sustainability game theory approach. In *Handbook of statistics* (Vol. 39, pp. 315-341). Elsevier.
- Ouyang, X., & Lin, B. (2017). Carbon dioxide (CO2) emissions during urbanization: A comparative study between China and Japan. *Journal of cleaner production*, 143, 356-368.
- Özokcu, S., & Özdemir, Ö. (2017). Economic growth, energy, and environmental Kuznets curve. *Renewable and Sustainable Energy Reviews*, 72, 639-647.
- Rafiq, S., Salim, R., & Nielsen, I. (2016). Urbanization, openness, emissions, and energy intensity: a study of increasingly urbanized emerging economies. *Energy Economics*, 56, 20-28.
- Salahodjaev, R. (2018). Is there a link between cognitive abilities and environmental awareness? Cross-national evidence. *Environmental research*, 166, 86-90.
- Shafik, N., & Bandyopadhyay, S. (1992). *Economic growth and environmental quality: time-series and cross-country evidence* (Vol. 904). World Bank Publications.
- Shafik, N., & Bandyopadhyay, S. (1992). *Economic growth and environmental quality: time-series and cross-country evidence* (Vol. 904). World Bank Publications.
- Spilker, G., & Koubi, V. (2016). The effects of treaty legality and domestic institutional hurdles on environmental treaty ratification. *International Environmental Agreements: Politics, Law and Economics*, 16(2), 223-238.
- Tiba, S., & Omri, A. (2017). Literature survey on the relationships between energy, environment and economic growth. *Renewable and Sustainable Energy Reviews*, 69, 1129-1146.
- Wangler, L., & Al Doyaili-Wangler, S. (2017). What drives compliance with international environmental agreements?: A political economy analysis of international and national determinants. In *Economics of International Environmental Agreements* (pp. 15-34). Routledge.
- Wehkamp, J., Koch, N., Lübbbers, S., & Fuss, S. (2018). Governance and deforestation—a meta-analysis in economics. *Ecological Economics*, 144, 214-227.
- You, W. H., Zhu, H. M., Yu, K., & Peng, C. (2015). Democracy, financial openness, and global carbon dioxide emissions: heterogeneity across existing emission levels. *World Development*, 66, 189-207.
- Zhang, B., Wang, Z., & Wang, B. (2018). Energy production, economic growth and CO2 emission: evidence from Pakistan. *Natural Hazards*, 90(1), 27-50.
- Zhou, T., Hu, W., & Yu, S. (2019). Characterizing interactions of socioeconomic development and environmental impact at a watershed scale. *Environmental Science and Pollution Research*, 1-13.