AMERICAN JOURNAL OF
ENVIRONMENTAL ECONOMICS (AJEE)
ISSN: 2833-7905 (Online)
VOLUME 2 ISSUE 1 (2023)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Environmental Economics (AJEE)

Volume 2 Issue 1, Year 2023
ISSN: 2833-7905 (Online)
DOI: https://doi.org/10.54536/ajee.v2i1.1640
https://journals.e-palli.com/home/index.php/ajee

Unraveling the Intricate Nexus of Philippine Environment and Economy: An Empirical Analysis Using Multiple Regression

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Article Information

Received: May 06, 2023
Accepted: May 23, 2023
Published: May 24, 2023

Keywords

CO_2 Emissions, GDP Per Capita, Primary Energy Use, Renewable Energy Consumption, Population Growth, Foreign Direct Investment, Philippines

ABSTRACT

A progressive country has sacrificed many things to achieve its goals, including using natural resources leading to environmental degradation. This study aimed to find out the status of the Philippines concerning environmental factors, specifically Carbon Dioxide (CO_2) Emissions, and how it is intertwined with various economic aspects, explicitly Gross Domestic Product (GDP) per capita, Primary Energy Use, Renewable Energy Consumption, Population Growth, and Foreign Direct Investment. The study employed multiple regression analysis to measure the relationship between environmental conditions and economic growth factors. The data secondary data used in the study was obtained from World Bank (1990 – 2014). Results yielded that the impact of GDP per capita has a positively significant relationship with carbon emission influencing a substantial increase. Consumption of primary energy use by households or businesses has extensive environmental consequences, especially with substantial population growth. Moreover, the utilization of renewable energy emerged as the most obvious approach the country should come up with to combat climate change and environmental deterioration as increased human activity necessitates the utilization of the environment and natural resources. Researchers suggest significant investments in climate change adaptation and combating for the country, considering the Philippine's strong potential for clean energy generation to avoid or even contend with the predicted ecological catastrophe by 2100.

INTRODUCTION

The environment is the most vital component of existence, and as a country, the environment has become increasingly crucial. Progress has greatly impacted our environment in one way or another. Human involvement and invention are aspects that contribute to a country's advancement and economic development, leading to either prosperity or distraction (Beckerman, 1992). The world's complexity also impacted the environment's health, which was mostly influenced by mankind's growth and development (Castiglione *et al.*, 2015).

Similarly, the elements employed in industrialization are typically nonrenewable leaving residuals that may pose a hazard and result in negative externalities (Aydin, 2019; Tiba & Omri, 2017). Environmental protection lags behind a country's quicker economic development, thereby impacting the environment (Shi *et al.*, 2019). Pollution is the main reason that leads to environmental degradation, which grows in the first stage but decreases in the second (Liu & Zhang, 2018) that presented the concept of the Environmental Kuznet Curve and how it impacts the environment as the economy is booming (Abdollahi, 2020).

Environmental degradation in high income countries is lessen compared to middle-income and low-income such that usage of nonrenewable shows significant increase in the latter (Naqvi *et al.*, 2021). The gap between high-, middle- and low-income nation is evident as developed countries can invest and allocate resources to sustainable renewable infrastructures compared to developing nations where income and resources are limited (Arndt *et al.*, 2018; Barger & Mattson, 2016; Elheddad *et al.*, 2021)

The fundamental argument for reducing carbon dioxide emissions is the necessity for government action and policy ramifications (da Rocha Lima Filho *et al.*, 2021; Nordmeyer, 2018). The disparity between economic progress and environmental degradation has been a point of contention.

The Objective of the Study

The main goal of this study is to determine the relationship between the environmental conditions and the economic growth factors and confirm whether the hypothesis of EKC Theory worked in the Philippines.

METHODOLOGY

This study employed a quantitative method (Creswell, 2013; Greene, 2013; Perreault, 2011) which examines the link between factors that may be quantified to evaluate objective hypotheses. Multiple Regression Analysis measures the relationship between the dependent and independent variables. Independent variables are variables whose values are known that can explain the dependent variable (Dhakal, 2018; Frieman *et al.*, 2022). In other words, Multiple regression is a statistical method for examining the connection between numerous independent variables and a single dependent variable. Multiple regression analysis aims to predict the value of a single dependent variable by using known independent variables (Moore *et al.*, 2006).

Likewise, several studies have used multiple regression to measure the relationship between the environment and

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economic development which elaborated the validity used in the study (Abdullah, 2015; Hosseini *et al.*, 2019; Wijaya, 2021)

The study makes use of the available secondary data from World Bank. These secondary data obtained was from the year 1990 to 2014 (a 25-year observation) in measuring the carbon dioxide emission (CO_2) and the economic factors thereof (Abdouli & Hammami, 2020). Furthermore, the variables used in the study and its descriptions are as follows:

Variables	Description
Carbon Emission (CO_2)	Annual CO_2 emissions (per capita)
Gross Domestic Product per Capita (GDP)	GDP per capita (constant 2015 US$)
Primary Energy Use (PE)	Energy use (kg of oil equivalent per capita)
Renewable Energy Consumption (RE)	Renewable energy consumption (% of total final energy consumption)
Population Growth (PG),	Population growth (annual %)
Foreign Direct Investments (FDI)	Foreign direct investment, net inflows (% of GDP)

Source: The World Bank (2021)

The gathered data was analyzed to regress and measure the relationship between the variables. Each predictor value is weighed, the weights denoting their relative contribution to the overall prediction.

$Y=\alpha+\beta_1X_{1i}+\beta_2X_{2i}+\beta_3X_{3i}+\beta_4X_{4i}+ \ldots..+\beta_nX_{ni}$

Here Y is the dependent variable, and $X_1,\ldots,X_n$ are the n independent variables. In calculating the weights, a, $b_1,\ldots,b_n$, regression analysis ensures maximal prediction of the dependent variable from the set of independent variables. This is usually done by least squares estimation (Moore *et al.*, 2006).

Model Specification

The regressor econometric equation model of the study is as follows:

$Y_i=\beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\beta_3 X_{3i}+\beta_4X_{4i}+\beta_5X_{5i}+\mu_i$

Where:

Y_i= represents the carbon dioxide (CO_2) emission of the i-th country;

B_0 = the intercept term;

β_{is}= efficiency parameters to be estimated;

X_{1i} = the gross domestic product per capita;

X_{2i} = primary energy use;

X_{3i} = renewable energy consumption;

X_{4i}= population growth;

X_{5i}= foreign direct investment; and

μ_i = represents the error term.

RESULTS AND DISCUSSIONS

Multiple regression was run to predict Carbon emissions from GDP per Capita, Primary Energy Use, Renewable Energy Consumption, and Foreign Direct Investment. The r2 and the adjusted r2 value indicate that the proportion of variance in the dependent variable can be explained by the independent variables with a value of 0.9864 and 0.9828, respectively, these independent variables explain 98% of the variability of the dependent variable. Furthermore, the output shows that the independent variables statistically significantly predict the dependent variable, $F(5, 19) = 275.93$, $p < 0.000$, thus, the diagnostic of the regression model is a good fit of the data and four out of the five independent variables statistically significant to the prediction, $p < 0.05$.

Similarly, the findings illustrate that GDP per capita (8276.662, $p < 0.0270$) has a significant positive association with carbon emissions, implying that a percent increase in GDP per capita would result in higher carbon emissions. This is supported by Apergis and Payne's (2014) analysis, which shows that per capita GDP and CO_2 emissions have a long-run relationship, denoting that as GDP per capita rises, CO_2 emissions will rise proportionately. Asumadu-Sarkodie and Owusu (2017), on the other hand, contradicted the findings, claiming that a percent rise in GDP per capita will reduce carbon dioxide emissions in the long run, based on EKC's concept that in the long term, as a nation develops, the environmental effect reduces.

Furthermore, the Primary Energy Use (219898.9, $p < 0.0000$) shows a significant increase in carbon emissions, proving that carbon emissions will increase as we continue using energy from coal, oil, natural gas, and other sources. According to Zhou and Gu (2020); Asumadu-Sarkodie and Owusu (2017); Dhakal (2009), the usage of fossil fuels and other energy sources increases CO_2 emissions from households, cities, provinces, and the country as a whole, considering non-renewables are used in the majority of goods (Adams & Nsiah, 2019; Alharthi *et al.*, 2021). Fisher and Irvine (2010), on the other hand, propose that the effect of energy consumption to carbon emission might be reversed if group-based interventions are applied. The intervention to address carbon emission is capable of 20% estimated reduction in a year and result in long-term changes in pro-environmental behavior.

Renewable Energy Use, on the other hand, has a negative significant association with carbon emissions (-4.93E+07, $p < 0.0020$), meaning that increasing renewable energy use will reduce carbon emissions which rendered as an aimed by every nation to combat climate change. This result is in line with Alharthi *et al.* (2021), who found that using renewable energy reduces carbon emissions significantly and would continue to do so as the amount expands. Moreover, the urgent need to transition from non-renewable to renewable energy consumption makes deploying energy-saving technologies even more crucial,

particularly in Asia's emerging economies (Hanif *et al.*, 2019). This transition is crucial because it directly impacts environmental quality (Balsalobre-Lorente & Leito, 2020). Consequently, by implementing energy-efficient technologies, organizations can effectively address this need while conserving energy, enhancing efficiency, and fostering their own growth, profitability, and sustainability (Hossain & Pk, 2023). However, according to Nguyen and Kakinaka (2019), not all countries may expect a reduction in CO_2 emissions when they use renewable energy; it was noted that low-income countries, when compared to their high-income counterparts, increase CO_2 emissions as they increase renewable energy use.

The relationship between population growth and carbon emission has shown highly significant (0.9601143, $p < 0.0000$) which means that through the increase in human activities, carbon emission increases. The findings coincide with the study of (Dong *et al.*, 2018; Knapp & Mookerjee, 1996; Sulaiman & Abdul-Rahim, 2018) in which in the short-run the human activities contribute to the increase in the carbon emission however (Ohlan, 2015; Pratama, 2021) would suggest otherwise that not only in the short-run can carbon emission be increase because of population growth but also in the long-run. Several authors have claimed that population growth positively significantly intensify carbon emission (Lawal, 2019; Masoud Abouie-Mehrizi, 2012; Rahman *et al.*, 2020). Contrary to the findings, (Begum *et al.*, 2015) stated that population growth does not have any significant association or sufficient evidence that it can positively affect carbon emission.

Foreign investment has no significant influence on carbon emissions, pertaining to the results. Other literature review has discovered a strong link between FDI and CO_2, with estimations determining that FDI has a beneficial impact on CO_2 emissions (Ewane & Ewane, 2023; Hou, *et al.*, 2021; Wu & Zhang, 2021; Zhou *et al.*, 2018). Gunarto (2020) verifies that there is no significant relationship between FDI and CO_2 emissions, indicating that it is not a contributor to the country's CO_2 emissions, in accordance with the study's inferences that FDI has no significant influence on CO_2 emissions.

Table 1: The Estimation Result Between CO_2 and Economic Factors

Carbon Emission	**Coef.**	**Std. Err.**	**t**	**P>t**
Constant	-1.09E+08	1.36E+07	-8.01	0.0000***
GDP per Capita	8276.662	3445.604	2.4	0.0270**
Primary Energy Use	219898.9	18984.41	11.58	0.0000***
Renewable Energy Consumption	-4.93E+07	1.39E+07	-3.54	0.0020***
Foreign Direct Investment	-852065.7	673231.3	-1.27	0.221
Population Growth	0.9601143	0.1047229	9.17	0.0000***
F(5, 19)	275.93			
Prob > F	0.0000***			
R-squared	0.9864			
Adj R-squared	0.9828			
Root MSE	2.00E+06			

Note: *P <0.10, **P < 0.05, ***P < 0.01

CONCLUSION

Based on the obtained results, the following conclusion was drawn:

1. The impact of GDP per capita has a positively significant relationship with carbon emissions influencing a substantial increase. As the nation grows and develop, the result of that realization is detrimental to the environment.

2. Consumption of primary energy use by any particulars such as household or businesses have extensive consequences to the environment. As a developing country, the high volume of energy consumption used by the different sectors heightens environmental degradation.

3. The utilization of renewable energy was the most obvious approach humans could come up with to combat climate change and environmental deterioration. Increased usage of renewable energy reduced the country's carbon emissions.

4. Increased human activity necessitates the utilization of the environment and natural resources whenever the population grows. These human activities exacerbate negative impacts on the environment and intensify carbon emissions.

RECOMMENDATION

In line with the outcomes discovered in the study, the area of renewable energy would be an interesting factor to delve deeper into. With a negative relationship with carbon emissions, it would be an important environmental dynamic for the country to invest in, considering the Philippines strong potential for clean energy generation. Additionally, with the worrying predictions of the country's ecological catastrophe by 2100 if significant investments to climate change adaptation is not made by 2020, more studies in the field of climate change solution

should be prioritized, leaning more towards gearing the agricultural and industrial sectors in developing equipment, policies, and practices that encourage sustainability for future generations.

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