

SMART

Journal of Business Management Studies

(A Professional, Refereed, International and Indexed Journal)

Vol-20 Number-1

January - June 2024

Rs. 500

ISSN 0973-1598 (Print)

ISSN 2321-2012 (Online)

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Founder - Publisher and Chief Editor



**SCIENTIFIC MANAGEMENT AND ADVANCED RESEARCH TRUST
(SMART)**

TIRUCHIRAPPALLI (INDIA)

www.smartjournalbms.org

**ENVIRONMENTAL AND MACROECONOMIC INDICATORS:
ANALYSIS FROM MALAYSIA**

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Abstract

The growing knowledge of global warming and the global action to mitigate, have caused a heightened sense of alarm about the root causes of the problem. In recent times, the connection between environmental damage and the economy has become the main issue in the area of environmental field. This paper proposes to investigate the association between macroeconomic indicators and carbon emissions. The macroeconomic indicators are Gross Domestic Product (GDP), Foreign Direct Investment (FDI), and Trade (T). Annual data of the variables were gathered for the period from year 1990 until 2021, and the results from Ordinary Least Square (OLS) regression had shown Trade and FDI to be significantly related to carbon emissions. The Autoregressive Distributed Lag (ARDL) results found that macroeconomic indicators affected carbon emissions in Malaysia. Hence, it is essential for

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the government to focus on attracting FDI that contributes to decarbonisation while reducing trade-related carbon emissions.

Keywords: *Carbon Emissions, Macroeconomic Indicators, Environmental Kuznets Curve, Autoregressive Distributed Lag, Ordinary Least Square*

JEL Code : *O13, O4, C4*

Paper Received : *10.10.2023*

Revised : *21.10.2023*

Accepted : *16.11.2023*

1. Introduction

Global warming has grown significantly worse in the recent years. The long-term warming, induced by greenhouse gas emissions, is now substantially greater than the year-to-year fluctuation in the world average temperatures, produced by naturally occurring climate factors. The rapid economic growth in Malaysia has been accompanied by an increase in carbon emissions since 1990. This is due to the high levels of energy required to fuel the growth of Malaysia. In 2021, Malaysia had reported a GDP of USD272.98 billion, despite the pandemic. At the same time, Malaysia had 251.555 mega tonnes of carbon emissions. This correlation between carbon emissions and economic growth, Indicates significant implications for the future of the planet. In the face of speedy rise in global warming, Economists have discovered the association between environmental degradation and economic development. The degradation of environment, affecting the economic development of a country, is sought to be explained by the Environmental Kuznets Curve (EKC) assumption.

The existing literature reveals that EKC assumption has not been supported by certain states (Rahman et al., 2020). Therefore, this study proposes to find out whether there is empirical relationship between carbon emissions and macroeconomic indicators, i.e., GDP, FDI and Trade and whether the EKC hypothesis holds good for Malaysia.

2. Literature Review

From the perspective of EKC, a rise in economic development would initially raise environmental pressure, but at a positive phase, a rise in economic growth will reduce the conservational problem. The EKC declares an inverted U-shape association between conservational deterioration and economy (Ahmad et al., 2017). The EKC assumption is related to the non-linear association between revenue stages and environmental ethics (Asongu & Odhiambo, 2020). The EKC is very valuable in researching the growth-pollutant relationship, especially for developing countries, that are currently attempting to enhance their economies (Dong et al., 2018).

$$Y_{it} = \alpha_{it} + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 X_{it}^3 + \beta_4 Z_{it} + \varepsilon_{it}$$

Where, Y refers to environmental, X refers to revenue or Gross Domestic Product per capita, Z is independent variable, ε_{it} is an error term, i refers to a country, and t is time. The X, X², and X³ establish the structure of the curve. As explained by Özokcu & Özdemir, 2017, there are different shapes of EKC and they are open to different interpretations. A monotonically reducing curve refers to environmental quality improving as revenue rises, while monotonically rising curve refers to environmental value becoming poor as revenue rises. Further, the quadratic specification, which is the inverted U-shape suggested by the EKC, shows environmental quality declining with the growth of revenue level, up to a certain position. Then,

environmental value recovers with a rise in revenue.

Growing levels of greenhouse gas emissions in the air are detrimental to the environment, due to carbon releases (**Nurgazina et al., 2021**). **Ali et al. (2020)** demonstrated that electricity generation had positive association with electricity consumption, leading to greater emissions. Further, **Raihan and Tuspekova (2022)** discovered how industry and agriculture strongly relied on fossil fuels. In addition, increase in economic development, urbanisation, industrialisation, and tourism increased CO₂ emissions, as established by a study, conducted by **Raihan et al. (2023)**, from 1990 to 2020.

A study, conducted in Malaysia, showed that unidirectional causality was established from carbon emission to GDP (**Aslam et al., 2021**). In addition, **Nurgazina et al. (2021)** found correlation between EKC hypothesis and GDP, generating carbon emissions. However, **Vo et al. (2019)** and **Gill et al (2017)** argued that EKC hypothesis was not applicable to Malaysia. A study, performed by **Shaari et al. (2022)**, found that FDI for Malaysia exerted direct impact on CO₂ emissions, suggesting that greater FDI inflows can worsen the environment in the country. Other studies also have found similar outcome for the association between FDI and carbon emissions in Malaysia (**Ridzuan et al., 2022**). According to **Kim, 2019**, FDI did not cause carbon emissions. Similarly, **Halliru et al. (2020)** also found that association between carbon emissions and trade was significantly negative. But, **Aslam et al. (2021)** found long-term association between carbon dioxide and trade in Malaysia.

3. Statement of the Problem

Issues, related to world warming and climate change, are becoming the greatest

significant hurdles to long-term growth in many global economies. The relationship between environmental deterioration and the economy has become a significant issue in environmental economics in recent years. For example, rapid economic growth in Malaysia has been accompanied by an increase in carbon emissions. This is due to the high levels of energy required to fuel its growth. The strong correlation between economic growth and carbon emissions may have significant implications for the future of the planet. The increased awareness against global warming and intention towards climate action worldwide, have resulted in concern about the determinants of this issue.

4. Need of the Study

Expansion is both the cause and remedy for environmental deterioration in Malaysia. Numerous scholars have attempted to find out whether economic development may be used to solve environmental concerns in the country. Hence this paper proposes to examine the association between macroeconomic variables, which are Foreign Direct Investment, Gross Domestic Product, Trade, and the Environmental Kuznets Curve, on Carbon Emissions. The study attempted to reduce this gap by utilizing the latest data, adding to the literature on environmental degradation.

5. Objectives of the Study

The aim of this paper was to investigate the long-term and short-term association between carbon emissions and macroeconomic factors, like Foreign Direct Investment (FDI), Gross Domestic Product (GDP), and Trade.

6. Hypotheses of the Study

NH-1: There is no significant association between carbon emissions and macroeconomic indicators (GDP, FDI & Trade).

NH-2: There is no long-term association between carbon emissions and macroeconomic indicators (GDP, FDI & Trade).

7. Methodology

7.1 Sample Selection

The sample for this research included Malaysian carbon emissions and macroeconomic indicators (GDP, FDI and Trade), from 1990 to 2021. Malaysia was chosen because it is one of the countries in the upper middle-income category. The dynamic modelling was employed, along with econometric models, to find out the association between carbon emission and GDP, FDI and Trade, test the hypotheses, and validate the theory of the Environmental Kuznets Curve.

7.2 Source of Data

The data were gathered from numerous platforms of sources accessible in websites. This paper utilized data from World Bank websites, except for carbon emissions, which were collected from the Countryeconomy.com.

7.3 Period of Study

This research covered a period of 31 years, from 1990 to 2021.

7.4 Tools used in the Study

Hypothesis testing, OLS regression analysis, and ARDL model were used in this paper. The association between carbon emissions and GDP was analysed under two different conditions: linear and quadratic in the EKC as well as the significant impact variables related to environmental deterioration i.e., FDI and Trade. Therefore, the empirical model was built, on the findings by previous researchers (Gill et al., 2017 and Ahmad et al., 2017).

$$CO_{2t} = \beta_0 + \beta_1 GDP_t + \beta_2 GDP_t^2 + \beta_3 GDP_t^3 + \beta_4 FDI_t + \beta_5 T_t + \varepsilon_t \quad (1)$$

Where, CO_{2t} is an environmental deterioration indicator for year t , CO_{2t} represents carbon emissions, GDP_t is gross domestic product, GDP^2 is gross domestic product squared, GDP^3 is gross domestic product cubed, FDI_t is foreign direct investment, T_t is trade, and v_{it} is an error term.

8. Data Analysis of Environmental and Macroeconomic Indicators in Malaysia

From **Table-1**, FDI and Trade are indicators under macroeconomics, that impact Malaysia's carbon emissions. Hence it was feasible to employ OLS model, utilising multiple regression test, to investigate the association between carbon emissions and macroeconomic factors, namely, FDI and Trade. The results concurred with **Koilo (2019)** for FDI variable. Trade negatively affecting carbon emissions, agreed with study results by **Halliru et al. (2020)**. Therefore, hypothesis NH-1: There is no significant association between carbon emissions and macroeconomic indicators (GDP, FDI & trade) was rejected, except for GDP. The value of the adjusted R^2 at 0.482, demonstrated that 48.2 percent of the changes in the carbon emissions can be explained by the explanatory variables. F-statistic showed significance level at one percent, indicating that the model was significant by fit.

Under the ARDL model, specifically bound test was established to evaluate the existence of any long-term association among the variables. According to **Table-2**, co-integration bound test revealed the computed F-statistics value to be 6.375, which exceeded the upper bound critical value, which was equal to 3.38 (5 percent significance level). Therefore, hypothesis NH-2: There is no long-term association between carbon emissions and macroeconomic indicators (GDP, FDI & Trade), was rejected. The co-integration bound test has

proved that there was co-integration long-run relationship, under this model. This result agreed with **Gill et al. (2017)**, who found long-term association among the indicators.

According to the regression result, presented in **Table-3**, FDI, GDP² and GDP³ were significant at 5 percent. This indicated that FDI would affect carbon emissions in the long-term. In addition, the result was similar to the results of the study done by **Rahman et al. (2020)**, who found strong long-term association between FDI and carbon emissions. Under the Short-Run ECM model, findings of ARDL (1,1,1,0,1,1) are exhibited in **Table 4**. GDP and FDI affected carbon emissions, but trade had no effect. This was supported by **Chng (2019)** and **Ahmad et al. (2017)**, who found short-run relationships between FDI, GDP and carbon releases. However, the inverse coefficient on the error-correction term, has established the existence of long-term relation among the indicators (**Mishra, 2012**). The ECM value was -1.028, which confirmed the long-term association among the indicators and this result suggested that any short-term deviation would be corrected by 102 percent, per annum, towards the long-term equilibrium. Finally, R-squared showed that 81 percent of the changes in carbon emissions can be attributed to explanatory variables. Hence hypothesis NH-1 and hypothesis NH-2 were rejected. The hypothesis NH-1 was rejected because there was association between emissions and macroeconomic indicators (GDP, FDI & Trade) while the NH-2 hypothesis was rejected because there was long-term association between carbon emissions and macroeconomic indicators.

Under the ARDL model, the coefficients were obtained for plotting the structure of EKC. The GDP's coefficient was 0.694 (**Table 3**), which was more than 0 and therefore, GDP and carbon emissions had reported monotonically

increasing relationship. From the EKC framework, the findings indicated no U-shape and inverted U-shape (Coefficient for GDP = 0.694 and Coefficient for GDP² = 0.441). In other words, the EKC hypothesis was not supported in Malaysia. As for quadratic function, coefficient was -0.040 for GDP³. **Gill et al. (2017)** also arrived at the same findings, that EKC assumption was not applicable to Malaysia.

9. Findings of the Study

The OLS regression output demonstrated that FDI and Trade had influenced carbon emissions in the short-term. This was consistent with the results by **Koilo (2019)** and **Halliru et al. 2020**, which found direct effect of FDI on carbon emissions and inverse effect of Trade on carbon emissions. Under the ARDL model, FDI and Trade affected carbon emissions in the long-term. Hence it is suggested that any short-term deviation could be corrected against the long-term equilibrium.

10. Suggestion

It is suggested that the Government should implement appropriate strategy to reduce carbon emissions in order to ensure sustainable economic growth. Since EKC hypothesis did not hold, the study revealed that environmental degradation can occur even in countries with high levels of income, and that relying on economic growth alone to address environmental issues may not be sufficient. Therefore, Malaysia should take proactive steps to ensure that their economic growth is sustainable and does not lead to excessive environmental degradation. For instance, FDI offers the opportunity to leverage technology and resources and this can reduce carbon emissions. The Government should initiate policies to create conducive environment, that encourages investments which support green technology and renewable energy resources. An example of this

policy, which is already in place in Malaysia, is the implementation of the concept of value-based intermediation (VBI), in which financial intermediary institutions play a role in compelling industry players to undertake green economic activities through their control over advancing loans or credits. The Government needs to find innovative solutions to reduce emissions, generated by international trade flow. This could include introducing policies that promote low-carbon production and subsidies for low carbon infrastructure. By taking these steps, the Government can ensure that FDI contributes to decarbonisation while reducing trade-related carbon emissions.

11. Conclusion

This paper investigated the association between carbon emissions and macroeconomic indicators as well as to validate the EKC hypothesis for Malaysia. By applying OLS regression with annual data from 1990-2021, this work successfully generated additional insights into the findings obtained. The results from OLS regression demonstrated that FDI and Trade exerted significant influence on carbon releases. In addition, the ARDL results found that macroeconomic indicators affected carbon releases in the long-term. But the results revealed that the EKC assumption was not applicable to Malaysia. This implied that economic growth alone cannot stem the environmental degradation, as suggested by the EKC assumption.

12. Limitations of the Study

This research experienced several limitations, especially from data accessibility. The study could use only 31 years of carbon emissions and macroeconomic indicators.

13. Scope for Further Research

This research suggests that other relevant variables could be employed to enable more comprehensive understanding of the subject. Gathering data from more resources also can provide more evidence and lead to the accuracy of the result, by analysing the latest data related to economic issues.

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Table-1: Ordinary Least Square (OLS) Result for Carbon Emissions and Macroeconomic Indicators in Malaysia (1990 – 2021)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	378.585	48.038	7.881	0.000
GDP	-4.291	2.253	-1.905	0.067
FDI	6.20E-09	2.25E-09	2.752	0.010
Trade	-1.049	0.279	-3.758	0.001

Note: At a 5% level of significance, R^2 is 0.532, adjusted R^2 is 0.482, and F -statistic is 10.625 with a p -value of 0.000

Source: Data extracted from world bank website, countryeconomy.com and computed using EViews 12.

Table-2: Autoregressive Distributed Lag (ARDL) Model – Bound Test (1990 - 2021)

Computed F-Statistics: 6.375	Critical Value	
	Lower Bound	Upper Bound
$k = 5, n = 30$		
1% significance level	3.06	4.15
5% significance level	2.39	3.38
10% significance level	2.08	3.00

Source: Data extracted from world bank website, countryeconomy.com and computed using EViews 12.

**Table-3: The Estimation of Long-Run Coefficients -
Long Run Cointegration (1990 – 2021)**

ARDL (1,1,1,0,1,1)				
Dependent Variable: CO ₂				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.067	2.925	1.049	0.308
GDP	0.694	0.482	1.441	0.166
GDP ²	0.441	0.212	2.085	0.051
GDP ³	-0.040	0.0174	-2.291	0.034
FDI	2.35E-09	9.48E-10	2.475	0.023
Trade	0.027	0.163	0.164	0.872

Source: Data extracted from world bank website, countryeconomy.com and computed using EViews 12.

Table-4: The Estimation of Short-Run ECM Model (1990 – 2021)

ARDL (1,1,1,0,1,1)		
Regressor	Coefficient	Prob.
ECM	-1.028	0.000
GDP	2.718	0.000
GDP ²	0.333	0.000
FDI	1.19E-09	0.001
Trade	-0.155	0.132
R ²	0.810	
Durbin-Watson	2.060	
F-Statistic	2.810	
Probability	0.025	

Source: Data extracted from world bank website, countryeconomy.com and computed using EViews 12.