The Impact Of Foreign Direct Investment On Environmental Quality In Some Southeast Asian Countries

Nguyen Thi Thoan[1,2], Xuan-Hoa Nghiem[1], Nguyen Thi Hong Tram[3], Tran Do Bao Chau[4*], Dang Thi Trang[1]

[1] Faculty of Economics and Management, International School, Vietnam National University, Hanoi, Vietnam

[2]Vietnam Institute for Economic and Policy Research, Vietnam National University, Hanoi, Vietnam

[3] Faculty of Development Economics, University of Economics and Business, Vietnam National University, Hanoi, Vietnam

[4]Faculty of Political Economy, University of Business and Economics, Vietnam National University, Hanoi, Vietnam

[*]Corresponding author: trandobaochau@vnu.edu.vn

Abstract

Research purpose:
The purpose of this research is to investigate the relationship between foreign direct investment (FDI) and environmental quality in Southeast Asian countries from 2000 to 2020, exploring how FDI contributes to environmental changes and CO_2 emissions, while also assessing the roles of economic growth and renewable energy.

Research motivation:
This study is motivated by the increasing concerns about global climate change and the need for Southeast Asian countries to balance economic development with environmental sustainability. As these countries experience significant FDI inflows, understanding the impact of FDI on environmental quality is crucial for policymakers aiming to promote sustainable development and meet climate change mitigation goals.

Research design, approach and method:
The research employs a quantitative approach using secondary data from the World Development Indicators for eight ASEAN countries over the period from 2000 to 2020. A panel data regression model is used, with methods such as pooled ordinary least squares (POLS), fixed effects model (FEM) and random effects model (REM) applied. The REM is selected based on model tests and generalized least squares (GLS) is employed to address heteroscedasticity and autocorrelation issues.

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Main findings:
The study finds a positive relationship between FDI and environmental quality in ASEAN countries, indicating that increased FDI contributes to higher emissions. Economic growth is also associated with increased CO_2 emissions, while renewable energy consumption helps reduce emissions.

Practical/managerial implications:
Policymakers in Southeast Asia are encouraged to focus on attracting green FDI, which emphasizes environmentally friendly technologies and industries. This shift will support sustainable development while minimizing CO_2 emissions. Additionally, promoting renewable energy adoption through government incentives and international cooperation will help mitigate the environmental impact of economic growth and contribute to regional climate change targets.

Keywords: Foreign direct investment, environmental quality, carbon dioxide emissions, ASEAN

1. INTRODUCTION

In the context of growing globalization, foreign direct investment (FDI) has become an important factor promoting the economic development of many nations. For developing countries in Southeast Asia, FDI not only contributes to promoting economic growth, but also creates profound changes in industrial structure and the environment. (UNCTAD, 2020). In this context, the link between FDI and carbon dioxide (CO_2) emissions has become an important research topic, as it has a direct impact on the issue of climate change and the environmental health of the area (Cole et al., 2011).

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The Southeast Asia region, with a rapid increase in investment from developed countries and multinational corporations, is experiencing dramatic changes in key industries such as manufacturing, energy, and transportation (ASEAN, 2021). These changes mean increases in productivity and national income, but also lead to an increase in CO_2 emissions, a major factor contributing to global climate change (World Bank, 2018).

One of the highlights of this study is the consideration of the impact of FDI not only from an economic perspective but also from an environmental perspective. Investment in heavy industries or outdated technology can lead to a significant increase in CO_2 emissions, while investment in clean technology or environmentally friendly industries can contribute to reducing emission levels (Zhang & Cheng, 2016). Therefore, a better understanding of this connection will help policymakers make smarter decisions to balance economic development and environmental protection.

The results of the study will provide insight into how FDI can be managed to optimize economic benefits while minimizing negative environmental impacts. Policy recommendations will be made to help Southeast Asian countries develop more sustainably, while contributing to global efforts to address climate change.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Foreign direct investment (FDI) has played a crucial role in driving economic growth in many nations, particularly in developing regions (IMF, 1999). However, the nexus between FDI and CO_2 emissions is increasingly attracting attention amid concerns about global climate change. Southeast Asia, with its rapid economic growth and increasing foreign investment, is facing the challenge of managing the balance between economic development and environmental protection (Jörn Dosch, 2010).

Research on the FDI-CO2 emissions relationship shows two conflicting views. The first view is that foreign direct investment has negative effects, increasing CO_2 emissions (Kivyiro and Arminen, 2014; Seker, 2015; To, 2019). Among them, Kivyiro and Arminen (2014) analyzed the time series from 1971 to 2009 for six sub-Saharan African countries, suggesting that CO_2 emissions and FDI have a positive relationship. Supporting this result, Seker (2015) when doing empirical research in Türkiye in the period 1974 - 2010, with the ARDL model, showed a modest but positive long-term impact of FDI on CO2 emissions. Recently, To (2019) found the extent of environmental degradation due to FDI in the case of emerging Asian countries during the period 1980 - 2016.

The second view advocates that foreign direct investment contributes to improving CO_2 emissions. Rafique (2020) discovered the positive role of FDI in reducing CO_2 emissions in BRICS member countries during the period 1990 - 2017. Similarly, Islam (2021) studied FDI in Bangladesh in the period 1972-2016 and showed that FDI contributed to reducing CO_2 emissions, thereby improving environmental quality. Jinchao Yi, Yilin Hou, and Zach Ziye Zhang (2023) supported this view by revealing a negative correlation between FDI and CO2 emissions in China, particularly in capital-, technology-, and labor-intensive industries, where FDI played a role in improving energy efficiency and facilitating environmental regulations. Along with that result, the study Pham Xuan Hoa and colleagues (2023) showed that FDI capital flows and economic growth have a strong positive impact on environmental pollution in Vietnam.

Regarding the impact of FDI on CO_2 emissions in several Southeast Asian countries, research findings also reveal opposing viewpoints. Yen Nguyen, Son Le, Nam Ngo, and Huyen Nguyen (2023), through an analysis using the Generalized Method of Moments (GMM) for ASEAN countries from 2000 to 2019, discovered that FDI tends to increase environmental pollution. Along with these findings, research by Rizky Eriandani and colleagues (2020) indicated a causal link between FDI in pollution-heavy industries and CO2 emissions in five ASEAN countries from 1980 to 2018. Additionally, Vuong Duc Hoang Quan (2017), employing Kuznets' theory, found an inverted U-shaped relationship between CO2 emissions and income in seven Southeast Asian countries from 1995 to 2014.

Meanwhile, some opposing views believe that foreign direct investment helps reduce CO_2 emissions in some East Asian countries (Ngo Ngan Ha, Phan The Cong, 2023). The recent increase in FDI into Vietnam has had an impact on reducing greenhouse gas emissions (Nguyen Thi Hoai Thu, 2023).

3. METHODOLOGY

3.1 Data source

This research uses secondary data from the World Development Indicators, comprising a panel dataset of 8 ASEAN member countries over the period from 2000 to 2020 with 168 observations. The selected countries include Cambodia, Indonesia, Lao PDR, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. Table 1 provides details on the variables used in the analysis, including their description, units, and the expected signs of their effects.

Table 1. Variables used in the analysis

Variable name	**Description**	**Units**	**Expected sign**
Dependent variable			
$LnCO_2E$	Natural logarithm of per capita carbon dioxide emissions	Metric tons per capita	
Independent variables			
$LnFDI$	Natural logarithm of net inflows of foreign direct investment	USD	+
$LnGDP$	Natural logarithm of GDP per capita	USD	+
$LnURPOP$	Natural logarithm of urban population as a percentage of total population	%	+
REC	Renewable energy consumption as a percentage of total final energy consumption	%	-
$CorrCon$	Control of Corruption index (0-100)	%	-

3.2 Model estimation

To analyze the impact of foreign direct investment on CO_2 emissions in some Southeast Asian countries, with the help of STATA 17, a regression model is proposed for the study as follows:

$$LnCO_2E_{\text{¿}} = \beta_0 + \beta_1 LnFDI_{\text{¿}} + \beta_2 LnGDP_{\text{¿}} + \beta_3 LnURPOP_{\text{¿}} + \beta_4 REC_{\text{¿}} + \beta_5 CorrCon_{\text{¿}} + \varepsilon_{\text{¿}} \qquad (1)$$

where i represents the countries studied in the panel data, i = 1…8; t represents the study period, t = 2000…2020.

Equation (1) represents coefficients such as $\beta_1, \beta_2, \beta_3, \beta_4$ and β_5. In addition, the model accounts for the ε error term and β_0 signifies a constant coefficient, which varies for each country but is time invariant.

The study uses panel data estimation methods, including the pooled ordinary least squares (POLS) method, fixed effect model (FEM) and random effect model (REM). These models have been used by Sapkota and Bastola (2017), Albulescu et al. (2019) when measuring the impact of FDI on CO_2 emissions.

To select the appropriate model, the following tests, as suggested by Park (2011), are used:

- Breusch-Pagan Lagrange Multiplier Test: This test checks for the significance of the random effects. If the result is significant, REM is more suitable than POLS.

- Hausman Test: This test is conducted with two hypotheses: (1) Null hypothesis (H_0): The explanatory variables and random component are uncorrelated, implying REM is appropriate; (2) Alternative hypothesis (H_1): The explanatory variables and random component are correlated, implying FEM is more suitable.

In addition, the authors use the following tests to detect model issues:

- Breusch-Pagan Test: Used to check for heteroskedasticity in the REM, with the null hypothesis (H_0) being that the model has no heteroskedasticity.

- Wooldridge Test: Used to detect autocorrelation in the error terms, with the null hypothesis (H_0) being that the model has no autocorrelation.

After evaluating the presence of heteroscedasticity and autocorrelation, GLS regression can be performed to correct these issues.

4. RESULTS AND DISCUSSION

The authors conducted tests to select one of the models: POLS, FEM, REM. The results are presented in Table 2 below:

Table 2. Regression results for POLS, FEM, REM

Variable name	POLS	FEM	REM
LnFDI	. 151***	.022	.029
	(.000)	(.427)	(.285)
LnGDP	. 349***	.305	.297*
	(.007)	(.105)	(.096)
LnURPO	. 952***	.625*	.721**
	(.000)	(.090)	(.040)
REC	-.010***	-.037***	-.035***
	(.000)	(.000)	(.000)
CorrCon	-.008*	-.010***	-.010***
	(.053)	(.001)	(.000)

¿*Cons*	-8.564***	-3.126**	-3.635*
	(.000)	(.015)	(.002)
N	168	168	168
R-squared	q	0.775	0.774
Hausman Test	0.662		
Notes: Standard errors are provided in parentheses. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively: ***p < 0.01, **p < 0.05, *p < 0.1.			

In Table 2, the Hausman test indicates that the REM regression model is better than the FEM regression model (p-value = 0.662 > 0.05) and therefore REM was selected as the appropriate model. The authors tested for model issues, including heteroscedasticity and autocorrelation, in the REM model. As shown in Table 3, both issues were detected.

Table 3. Diagnostic test results

Test	Value	Result
Breusch-Pagan Test for heteroscedasticity	Prob>chi2 = 0.000	Heteroscedasticity detected
Wooldridge Test for autocorrelation	Prob > F = 0.000	Autocorrelation detected

To correct for heteroscedasticity and autocorrelation, the study used Generalized Least Squares (GLS) estimation, with the results shown in Table 4:

Table 4. GLS estimation results

Variable name	GLS
LnFDI	.013***
	(.007)
LnGDP	.493***
	(.000)
LnURPOP	.330
	(.127)
REC	-.015***
	(.000)
CorrCon	-.001
	(.696)
¿*Cons*	-4.325***

	(.000)
Notes: Standard errors are provided in parentheses. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively: ***p < 0.01, **p < 0.05, *p < 0.1.	

Removing statistically insignificant variables, the GLS model estimation resulted in the following equation:

$$LnCO_2E_{¿} = -4.325 + 0.013 * LnFDI_{¿} + 0.493 * LnGDP_{¿} - 0.015 * REC_{¿} \quad (2)$$

The regression results show that:

The positive relationship between FDI and CO_2 emissions in ASEAN countries suggests that increased FDI contributes to higher carbon emissions. The regression result, significant at the 1% level, shows that a 1% increase in FDI leads to a 0.013% rise in CO_2 emissions, assuming other factors remain constant. This finding can be explained by the "pollution haven hypothesis," which argues that multinational corporations tend to relocate their operations to countries with lax environmental regulations, resulting in higher pollution levels in the host country. Cole and Elliott (2005) demonstrated that FDI could exacerbate environmental degradation in developing countries, especially when regulations are insufficient to control emissions. Moreover, industries attracting FDI in ASEAN countries, such as manufacturing and extractive sectors, tend to be carbon-intensive, further supporting this result. For instance, in Vietnam, FDI inflows are concentrated in sectors like heavy industry and mining, which rely heavily on fossil fuels, contributing to higher emissions (Al-Mulali et al., 2015). These sectors increase the demand for energy and resources, which, in turn, exacerbates environmental pressures.

The regression analysis also shows that economic growth in ASEAN countries is positively correlated with CO_2 emissions. At the 1% significance level, a 1% increase in economic growth leads to a 0.493% rise in CO_2 emissions. This finding aligns with the environmental Kuznets curve (EKC) hypothesis, which suggests that economic growth at early stages of development is associated with higher pollution levels as countries prioritize industrialization and energy consumption. Suri and Chapman (1998) argued that rapid economic expansion in developing nations often comes at the cost of environmental sustainability, as fossil fuel consumption rises to support industrial and infrastructure growth. In the context of ASEAN, many countries rely on energy-intensive sectors to drive economic development, which is consistent with the observed positive relationship between GDP growth and emissions. This economic model, while generating short-term gains, has long-term environmental consequences, which may complicate efforts to achieve sustainable development goals.

On the other hand, renewable energy demonstrates a negative relationship with CO_2 emissions in ASEAN countries. The regression analysis shows that a 1% increase in the share of renewable energy results in a 0.015% decrease in CO_2 emissions, suggesting that the adoption of cleaner energy sources has a mitigating effect on environmental degradation. This result is significant and is supported by prior research, such as the work of Adedoyin et al. (2020), who found that increased investment in renewable energy helps reduce the carbon intensity of economic activities. ASEAN countries have made significant progress in expanding renewable energy infrastructure, particularly in the areas of solar, wind and hydropower.

5. CONCLUSION

The study employed the Random Effects Model (REM) to investigate the impact of foreign direct investment (FDI), economic growth, urbanization, renewable energy use and corruption control on CO_2 emissions in several ASEAN countries during the period from 2000 to 2020. The results indicate a positive relationship between FDI and economic growth with CO_2 emissions and a negative relationship between renewable energy use and CO_2 emissions in these countries. However, the study found no statistical significance of urbanization and corruption control on CO_2 emissions. Based on these findings, the study proposes several policy recommendations to reduce CO_2 emissions in Southeast Asian countries as follows:

First, enhance the attraction of green FDI. Southeast Asian countries need to pay more attention to setting environmental standards when attracting foreign investment. These countries should shift from broad-based FDI attraction to focusing on investments that use advanced technology and protect the environment. To achieve this, governments should develop clear strategies for attracting green FDI, ensuring a transparent and fair investment environment. Additionally, governments need to establish strict legal and environmental standards to encourage businesses to adopt sustainable production practices. Creating green industrial zones, offering tax and land incentives for green FDI projects are also effective solutions. Specifically, Southeast Asian countries should focus on green industries. Prioritizing investment in sectors such as renewable energy, organic agriculture, waste management and circular economy will not only help protect the environment but also create new job opportunities and promote sustainable economic growth. Furthermore, developing industry clusters centered on green technology will create spillover effects, foster innovation, and enhance the competitiveness of businesses in the region.

Second, control economic growth towards sustainability. Countries in the region should integrate environmental protection factors into their economic growth strategies. This includes encouraging the development of sustainable industries and supporting businesses in adopting energy-saving and waste-reducing technologies. Governments should also implement training programs and raise awareness about sustainable development for businesses and communities. Singapore is a successful example in the region, having adopted sustainable growth policies and advanced technologies in production to reduce emissions. Other ASEAN countries can learn from Singapore's model to reduce CO_2 emissions without negatively impacting economic growth.

Third, develop and encourage the use of renewable energy. To achieve greenhouse gas reduction targets in line with COP26 commitments, Southeast Asian countries need to focus on developing and deploying renewable energy sources. Governments should invest in research and development of renewable energy technologies such as solar and wind power. Additionally, incentive policies, such as tax reductions, capital support and land access facilitation, should be implemented to encourage businesses to invest in renewable energy projects. To ensure the energy transition occurs efficiently and sustainably, Southeast Asian countries need to enhance international cooperation, sharing experiences, technology, and resources among countries in the region.

The limitation of this study lies in the use of data from the pre-COVID-19 period. The complex developments of the pandemic at different stages may have impacted the socio-economic indicators in the model. Additionally, the study faces challenges due to the significant disparity in development levels among ASEAN countries, highlighting the need to explore differences between highly and less developed nations in the region, which has not yet been addressed. Moreover, the study has not considered energy indicators - a crucial factor influencing CO2 emissions.

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