ENVIRONMENTAL MANAGEMENT AND THE INFLUENCE OF FOREIGN DIRECT INVESTMENT IN SOUTHEAST ASIA: POLICY IMPLICATIONS

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Abstract: This study investigated the nexus between environmental pollution measured by carbon dioxide (CO2), nitrogen dioxide (N2O) and net Foreign Direct Investment (FDI), along with some other variables, namely economic growth by gross domestic product per capita, trade openness, manufacturing, political stability, urbanization, and population growth, using annual data of 11 countries from Southeast Asia for the period from 1999 to 2019. After testing the suitability of the fixed effects and random effects model, this study used the former. The results show that FDI inflows cause CO2 levels to increase in Southeast Asia, supporting Pollution Heaven Theory. However, as for N2O level, the result is not significant, meaning that there is no relationship between FDI inflows and N2O level. Other variables, including GDP and trade openness, negatively affect the environment in Southeast Asia as well. Some recommendations for the Southeast Asia government are also provided to improve the environmental condition in this region.

Keywords: Foreign direct investment, environment pollution, economic growth

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Introduction

Due to economic openness, Foreign Direct Investment (FDI) is vital for expanding economic activities and overall progress. FDI comes mainly from developed countries, and the destination of FDI is usually the developing countries. More specifically, the proportion of inward FDI in developing countries has witnessed a striking rise from 29 per cent in 1970 to nearly 47 per cent in 2011 (UNCTAD, 2013). Southeast Asia, including eleven countries (Brunei, Myanmar, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Timor-Leste and Vietnam), is involved in this development. The inflows of FDI into Southeast Asia took off comparatively late, until 1980, compared with other regions. However, the

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level has kept climbing since then. In the research conducted by Hoang and Bui (2014) from 1980 to 1997, Southeast Asia was considered "a red destination" for international investors, taking up 8% of the world's total FDI at that time. In 2019, the level of FDI inflows into Southeast Asia recorded a significant increase, up 3% to $149 billion (UNCTAD, 2019).

Along with bringing benefits to a host country's economy, however, FDI inflows also expand pollution (Khan, 2020). French (1998) pointed out the reason for this nexus and aiming to seek the highest return on investment around the globe, would search for places providing abundant natural resources but with ineffective or weak environmental laws. According to World Bank data, Southeast Asia's pollution level has risen significantly. Many factors contribute to the increase in pollution (Rajiani, 2018). However, many believe one of the main factors is FDI inflow. Overall, from 1990 to 2014, most countries in this region experienced a surging level of CO2 emissions, especially Indonesia.

The effects of FDI inflows on the environment have received much attention from governments and academic researchers (Omri and Nguyen, 2014). There are two main theories related to this issue. The first one is called the Pollution Heaven theory, which implies that FDI-led expansion will increase the pollution level of a country. The Pollution Heaven Hypothesis (PHH) suggests that multinational companies may choose to relocate the production of goods that create a lot of pollution to developing countries with less strict pollution regulations. They do this in order to reduce costs and attract foreign investments, which can lead to economic growth. The second one is called the Halo effect, which suggests that the advantage of FDI comes mainly from the technology transfer process from developing countries, encouraging the overall economy's growth.

There is vast research examining the nexus between FDI inflows and the level of environmental pollution. However, not many papers have concluded which theory is predominant regarding the inflow of FDI, especially in Southeast Asia. Therefore, This study aims to examine the relationship between the inflows of FDI into Southeast Asia countries and the environmental pollution in this region from 2000 to 2019, taking the gross domestic product (GDP), openness, industry, manufacturing, political stability, urbanization, and population growth rate as control variables. Carbon emission and nitrogen dioxide index will be used to measure the extent of pollution in Southeast Asia countries.

Literature Review

International firms engage in FDI to gain benefits, mainly aiming to lower costs through proximity and concentration. Moreover, FDI is believed to promote economic growth, especially by spreading technology (Lin, Liu and Zhang, 2009). Besides, the technology spillovers because of FDI contributed to economic development (Liu et al., 2016). FDI also fosters job creation, reduces unemployment (Javorcik, 2012), and aids human resource development through staff training (Afza

and Nazir, 2007). Furthermore, FDI fosters competition and breaks domestic monopolies (Jugurnath, 2018).

However, in recent years, the increase in the level of FDI inflows and outflows, along with the signs of environmental degradation, has urged researchers to examine the link between FDI and environmental pollution. There have been numerous studies examining the association between FDI and the environment based on PHH and Halo effect, such as Zarsky (1999), Eskeland and Harrison (2003), Wheeler (2002), Maryam Asghari (2013), Dauda et al. (2019). Despite that, conclusions have not reached a consensus (Kheder, 2012) due to limitations in the databases and differences in conceptual frameworks (Letchumanan and Kodama, 2000).

Machado et al. (2001) examined the impacts of international trade on energy use and CO2 emissions in the Brazilian economy. They found that the accumulated amount of energy and l carbon emissions embedded in the non-energy goods export was significantly greater than the appropriate amounts embodied in the imports of non-energy goods, which supports the PHH.

Gill et al. (2018) studied how trade liberalization, including FDI, affected the environment based on PHH. They stated that "owing to international trade and foreign direct investment (FDI), the developing countries have become the pollution haven for the advanced countries".

In the research conducted by Ur Rahman et al. in 2019, they supported the PHH in the context of Pakistan for the period 1975-2016 by employing a non-linear autoregressive distribution lag (NARDL) approach. The conclusion was that there was a symmetric association between FDI inflow and CO2 emissions in both the short and long run.

Besides PHH, others proved the Halo effect, meaning that FDI inflows benefit the environment. Doytch and Uctum (2016) defined the halo effect hypothesis as "Multinational companies disseminate superior knowledge and apply environmentally friendly practices while improving the environmental performance of the domestic business".

Asghari (2013) pointed out two reasons for this hypothesis. Firstly, cleanliness is probably driven by external factors. For example, OECD-based firms usually utilize cleaner technology and process more complicated and stringent management systems to protect the environment than domestic firms due to the stringent regulatory environment in the OECD (Zarsky, 1999). These firms have the pressure to continue to use clean technologies in their affiliates in the host countries because such firms have large export markets in OECD countries where they need to comply with environmental regulations. The second reason is internal factors like the firm's management practices or strategies.

Furthermore, several other studies have established a clear connection between foreign direct investment (FDI) and environmental development. For instance, Demena and Afesorgbor (2020) successfully demonstrated the presence of Halo effects in European countries. Additionally, Dong et al. (2019) confirmed the existence of Halo effects resulting from FDI in China.

Besides, several studies indicate that FDI does not correlate with increased or decreased environmental pollution. Atici (2012) researched the link between trade and CO2 emissions in the ASEAN group of countries for 1970-2006 and concluded that CO2 emissions were mainly due to exports from the ASEAN countries, FDI had minor negative influences on CO2 emissions, indicating that FDI did not contribute to environmental degradation in these countries.

As for Southeast Asia countries, even though they are some of the nations receiving much FDI, there is almost no existing literature examining the effects of FDI on the environment in this region. The studies on FDI inflows' impacts on Southeast Asia countries started early. In 1993, Fry published a book titled "Foreign Direct Investment in Southeast Asia: Differential Impacts" with a primary emphasis on how FDI influenced the region. However, the book primarily concentrated on economic growth, savings, and the volume of exports and imports rather than delving deeply into FDI's environmental consequences. The environmental aspect of FDI was only briefly touched upon in this book and did not receive significant attention. Subsequently, several other studies have emerged to investigate the impact of FDI inflows in Southeast Asia, including works by Lee (2009), Khan (2020), and Ansari et al. (2019). However, none of them mentioned the nexus between FDI and environmental pollution. Therefore, given the mixed results of prior research, it seems that the motivation to study the relationship between FDI inflow and environmental pollution in the Southeast Asia region. In this research, two main hypotheses are presented:

H1: Foreign direct investment inflows have negative effects on the environment in Southeast Asia

H2: Foreign direct investment inflows have positive effects on the environment in Southeast Asia

Research Methodology

This study examines the nexus between environmental pollution measured by CO2 and N2O and FDI inflows into Southeast Asia countries, taking the gross domestic product (GDP), openness, manufacturing, political stability, urbanization and population growth rate as control variables. The data are yearly, covering eleven Southeast Asia countries, including Brunei, Myanmar, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Timor-Leste and Vietnam, spanning from 1999 to 2019.

Table 1. Measurement of variables

Variables	Proxy symbol	Measurement unit	Type	Data source
Carbon dioxide emissions	CO2	Kilotons (kt)	Dependent variables	WDI
Nitrogen dioxide	N2O	Thousand metric tons	Dependent variables	WDI
Foreign direct investment	FDI	Billion USD	Independent variable	WDI
Economic growth	GDP	Million USD	Independent variable	WDI
Trade openness	Trade	% of GDP	Independent variable	WDI
Manufacturing	Manufacturing	% of GDP	Independent variable	WDI
Political stability	Political stability	Index	Independent variable	WGI
Urbanization	Urbanization	Annual percentage	Independent variable	WDI
Population growth	PopGrowth	Annual percentage	Independent variable	WDI

Source: Own elaboration based on WDI and WGI stand for Global Carbon Atlas, World Bank, World Development Indicators and World Governance Indicators, respectively.

Apart from FDI, other variables have been proven to have a link to environmental degradation. Firstly, there are a lot of studies demonstrating the relationship between GDP and environmental issues. This relationship is illustrated via the theory called "Environmental Kuznets Curve" (EKC), developed by economist Simon Kuznets in

the 1950s and 1960s. Some empirical researchers examining this relationship are Doytch and Uctum (2016) on the effects of globalization on the environment using EKC, Harbaugh and Wilson (2002) on reexamining the EKC, etc.

Secondly, as for trade openness, Copeland and Taylor (2013) pointed out the two key channels through which trade openness can influence the environment: the scale effect and the composition effect. Mahrinasari (2019) also proved the positive relationship between trade openness and CO2 emission.

Thirdly, Torras and Boyce (1998) pointed out that the increase in manufacturing will worsen the environmental quality, and Lopez (1994) showed that energy-based activities such as manufacturing and transportation typically consume high-energy products and produce pollution by emitting toxic gases like CO2, N2O, SO2, etc. Moreover, the link between political stability and pollution was examined by Purcel (2019), who found that political stability helped mitigate CO2 pollution in developing countries. Last but not least, urbanization and population growth were proven to be related to environmental pollution. For example, Liu and Wang (2017) pointed out atmospheric pollution from fuel combustion in crowded areas.

Descriptive Statistics

Table 2 shows the descriptive statistics of the variables' data:

Table 2. Descriptive statistic of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	231	109291.4	141776.6	161.348	637078.9
N2O	231	22985.7	33686.74	156.9192	243198.7
FDI	231	-3.637308	9.229415	-72.18224	10.5516
GDP	231	159.2646	214.3914	0.3670857	1119.191
Trade	231	126.5282	90.32308	0.1674176	437.3267
Manufacturing	231	18.06727	7.846918	0.721291	31.95328
Urbanisation	231	2.685178	1.081381	-1.474533	6.389769
Political Stability	231	-0.181619	0.9511933	-2.09	1.62
Population	231	1.419125	0.6457277	-1.474533	5.321517

Overall, the environmental condition in Southeast Asia is alarming, with the average amount of CO2 and N2O being high, almost 110000 kilotons and 23000 thousand metric tons, respectively. According to the World Bank (2015), most global deaths from pollution came from East Asia and the Pacific, taking up to 35% and from

South Asia, accounting for 33%. As for macroeconomic factors, inward FDI, on average, is still low.

Moreover, Southeast Asia has a high population growth rate, with an average of 1.4 and a maximum of 5.3. Based on the data collected, countries with low GDP tend to have a high population growth rate, equivalent to studies conducted by Barlow (1994) and Coale and Hoover (2015). Along with rapid urbanization, the political stability index of this region illustrates the instability, with the average being negative.

Regression Model

The researchers use the quantitative method to examine the research question, which "addresses research objectives through empirical assessments that involve numerical measurement and analysis" (Zikmund, 2013), to identify the nexus between FDI and environmental pollution in Southeast Asia countries. The impact of FDI on the environment in this region through the following regression model as below:

$$CO2emission_{i,t} = \alpha + \beta_1 FDI_{i,t} + \beta_2 GDP_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Manufacturing_{i,t} + \beta_5 PoliticalStability_{i,t} + \beta_6 Urbanization_{i,t} + \beta_7 PopGrowth + \varepsilon_{i,t} \quad (1)$$

$$N2O_{i,t} = \alpha + \beta_1 FDI_{i,t} + \beta_2 GDP_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Manufacturing_{i,t} + \beta_5 PoliticalStability_{i,t} + \beta_6 Urbanization_{i,t} + \beta_7 PopGrowth + \varepsilon_{i,t} \quad (2)$$

Where, *i* and *t* represent countries and years (t = 1999-2019), respectively. When it comes to independent variables, the main one is $FDI_{i,t}$. The control variables are $GDP_{i,t}$- stand for Gross Domestic Product, $Trade_{i,t}$ - stands for Trade Openness, which is the aggregate import and export as a percentage of GDP, $Manufacturing_{i,t}$ - stand for manufacturing as a percentage of GDP, $PoliticalStability_{i,t}$ - stand for political stability index, $Urbanization_{i,t}$ - stands for urbanization index, and PopGrowth for population growth rate. The last factor in the model is $\varepsilon_{i,t}$ – the firm-yearly specific error term to deal with heteroscedasticity and serial correlation.

However, there can be some omitted variables in these models. Therefore, based on the simple regression models above, the authors use the Fixed and Random effects models, the two most popular in the meta-analysis, to test whether the omitted variables are fixed or random. The fixed-effect model assumes that one effect size is underlying all the studies in the analysis, and sampling error causes all differences in observed effects. (Borenstein et al, 2010).

The fixed effects model is widely used in research due to its efficiency. Du et al. (2012) used the fixed effects model to study China's economic development and carbon dioxide emissions relationship based on provincial panel data analysis from 1995 to 2009. Haisheng et al. (2005) also used a fixed effects model to examine the impact on the environmental Kuznets curve by trade and foreign direct investment in China from 1990 to 2002. Llorca and Meunie (2009) studied SO2 emissions and the environmental Kuznets curve in Chinese provinces, taking the fixed effects

model as the methodology.
The models are now presented as:

$$CO2emission_{i,t} = \alpha + \beta_1 FDI_{i,t} + \beta_2 GDP_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Manufacturing_{i,t} + \beta_5 PoliticalStability_{i,t} + \beta_6 Urbanization_{i,t} + \beta_7 PopGrowth + \mu_i + \delta_{i,t} \quad (3)$$

$$N2O_{i,t} = \alpha + \beta_1 FDI_{i,t} + \beta_2 GDP_{i,t} + \beta_3 Trade_{i,t} + \beta_4 Manufacturing_{i,t} + \beta_5 PoliticalStability_{i,t} + \beta_6 Urbanization_{i,t} + \beta_7 PopGrowth + \mu_i + \delta_{i,t} \quad (4)$$

μ_i estimates the common change/difference (to all years) in the pollution rate in country i relative to country 1 (Brunei), controlling for FDI inflows, GDP, Trade, Manufacturing, Political Stability and Urbanisation rate to all countries (the year fixed effects). The researchers call μ_i country has a fixed effect precisely because the difference is common to all years in countries i; in other words, the 'effect' of the city i is 'fixed' across all years.

The Correlation Matrix

Table 3. Correlation

	FDI	**GDP**	**Trade**	**Manufacturing**	**Urbanization**	**Political Stability**	**Population**
FDI	1.0000						
GDP	-0.3358	1.0000					
Trade	-0.4440	-0.0233	1.0000				
Manufacturing	-0.0034	0.3697	0.2315	1.0000			
Urbanisation	0.2248	-0.1067	-0.0520	-0.0543	1.0000		
Political Stability	-0.3489	-0.1587	0.6474	-0.2291	-0.0783	1.0000	
Population	0.1078	-0.1416	0.3012	-0.0502	0.3630	0.1822	1.0000

As can be seen from Table 3, the correlations between explanatory variables are quite low. Overall, there will be almost no concern about the multicollinearity issue in this model.

Findings

Table 4 and 5 reveal how independent variables, including GDP, Trade, Manufacturing, Urbanization and Political Stability, influence CO2 and N2O emissions, representing the pollution level. Besides, ten dummy variables illustrate the common difference (to all years) in the pollution rate in country i (including Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam) relative to Brunei.

Overall, it can be said that the two models have good explanatory power with the adjusted R-squared are 98% and 87%, respectively. R-squared reflects how well our regression model captures the relationship between dependent and independent variables. A higher R2 ($0<R2<1$) implies, everything else being equal, that the model fits the data better. The R-Squared must be adjusted in case of a multiple regression comprising several explanatory variables. For the first model, independent variables can explain 98% of the dependent variable (CO2). Similarly, the regressors can explain 87% of the second model's dependent variable (N2O).

More specifically, as for model (Eq (3)) whose dependent variable is CO2 emissions, the p-values of the three first explanatory variables (FDI, GDP and Trade) are statistically significant at the significance level of 5%, meaning that a change in these factors results in a change in CO2 level. The coefficient of FDI is almost 635.5, meaning that a one billion USA increase in FDI inflows will lead to 635.5 kilotons in CO2 emissions. This amount is significant. Therefore, it can be concluded that FDI inflows lead to environmental degradation. Besides, GDP growth and trade openness are also elements leading to the severity of environmental pollution. The coefficient of GDP indicates that an increase of 1 billion USA in GDP will result in the addition of 341 kilotons of CO2 into the air, implying that environmental pollution is a consequence of economic growth.

Similarly, trade openness also contributes to the degradation of the environment in Southeast Asia. The coefficient of 228 illustrates the increase of 228 kilotons of CO2 emission when one percentage of trade openness is recorded. The other four explanatory variables, manufacturing, urbanization, population growth rate and political stability, have P-values of 0.25, 0.31 and 0.41, indicating that these factors are not statistically significant and do not affect CO2 emissions in Southeast Asia.

This study uses dummy variables with country-fixed effects to examine different countries' extent of impact on pollution levels. Based on the results in Table , taking Brunei as the benchmark, Cambodia, Laos and Myanmar have p-values over 0.1, indicating statistical insignificance. Therefore, as for these three countries, it can be said that their extent of impact on the environment is equivalent to Brunei's. The other countries, including Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam, have p-values under 0.1, meaning they are statistically significant. Compared to Brunei's CO2 emission, that amount of Indonesia is more remarkable, by 250000 kilotons.

Similarly, Malaysia, Myanmar, Philippines, Thailand and Vietnam emit 105441,

13466, 30489, 146709 and 69555 kilotons more than Brunei. Singapore is the country with the lowest CO2 emissions in the region. Among eleven Southeast Asia countries, Indonesia "contributes" most to environmental degradation. Indonesia is one of the most appealing destinations for multinational firms, with FDI inflows accounting for USD 23,4 billion in 2019 (UNCTAD, 2020). The liberalization policy has enabled Indonesia to rank 17th among the top 20 host economies. Indonesia ranks second in attracting FDI in Southeast Asia, led by Singapore.

Table 4. Result of regression (Eq(3))

Dependent variable (CO2)		
Variable	**Coef.**	**P Value**
FDI	740.4825*	0.001
GDP	343.6862*	0.000
Trade	265.3648*	0.002
Manufacturing	-856.839	0.192
Urbanization	632.8084	0.823
Politicalstability	-2320.546	0.575
Population	-6540.739	0.137
Country1		
Cambodia	-7976.143	0.407
Indonesia	249181.8	0.000
lao PDR	-4468.553	0.681
Malaysia	105441.2	0.000
Myanmar	13466.05	0.329
Philippines	30489.52	0.048
Singapore	-81013.96	0.000
Thailand	146709.3	0.000
Vietnam	69555.65	0.000
_cons	-756.0467	0.949

Note: Asterisk indicates estimated coefficients are significant at 5% level.

As for model Eq(4), the dependent variable is N2O, and the p-value of all explanatory variables except for trade openness is above 0.1, meaning that these regressors are not statistically significant and the rise in these factors does not impact

the increase of N2O. The only factor influencing the emission of N2O is trade openness, with its p-value of 0.098, indicating statistical significance at the level of 10%. The coefficient of this factor is 265, meaning that a one percentage increase in trade openness will result in a rise of 265 thousand metric tons in N2O emissions.
Among eleven countries in Southeast Asia, Indonesia has a p-value of 0.000, meaning statistical significance at the level of 5%. Based on its coefficient, Indonesia still emits the highest level of N2O, with the amount of N2O emission exceeding that of Brunei by 131000 thousand metric tons. Similar to the first model, Malaysia, Myanmar, Philippines, Thailand and Vietnam have p-values under 0.05, meaning that they are statistically significant at the level of 5%. These countries emit 17386, 31921, 17351, 32041 and 26603 thousand metric tons more than Brunei. Singapore is still the least contaminated country in the region.

Table 5. Result of regression (Eq(4))

Dependent variable (N2O)		
Variables	**Coef.**	**P Value**
FDI	-1.524256	0.991
GDP	-10.85162	0.234
Trade	86.10184*	0.098
Manufacturing	-597.6237	0.140
Urbanisation	-1413.186	0.417
Political stability	-1897.996	0.457
Population	-1076.617	0.691
country		
Cambodia	10307.6	0.083
Indonesia	130964	0.000
lao PDR	6708.654	0.317
Malaysia	17386.74	0.021
Myanmar	31921.94	0.000
Philippines	17351.37	0.068
Singapore	-13402.6	0.312
Thailand	32014.3	0.002
Vietnam	26603.72	0.000
_cons	6664.019	0.359

Note: Asterisk indicates estimated coefficients are significant at 10% level.

In conclusion, FDI is proven to be one of the factors leading to environmental degradation in Southeast Asia countries. Although the relationship between N2O and FDI is not significant in this paper, it can not be denied that FDI still has an impact on pollution in eleven countries in Southeast Asia via the positive correlation between CO2 and FDI. The rise in FDI leads to an increase in CO2. These two models are not contradictory. Therefore, the study accepts the first hypothesis supporting the "Pollution haven theory" and rejects the "Halo effect" theory. The reason why N2O is not influenced by FDI has been elucidated by Chapuis-Lardy et al. (2007) and Schlesinger (2013). They argue that the emission of N2O at the soil/atmosphere interface primarily results from agricultural production and household consumption processes rather than being linked to industrial output, which is the primary source of inbound FDI.

Similarly, according to Vallero (2016), nitrous oxide is emitted into the atmosphere predominantly due to human activities, especially the cutting and clearing of tropical forests. Moreover, models Eq(3) and Eq(4) reveal that urbanization, political stability, manufacturing and population growth do not affect the pollution of the environment in Southeast Asia. Besides FDI, two other factors GDP and trade, are proven to be elements of the degradation of the environment. Among eleven countries, Singapore appears to be the least polluted country, while Indonesia is Southeast Asia's main source of emissions.

Conclusion

Since FDI contributes to a higher level of environmental pollution in Southeast Asia countries via the positive relationship between inward FDI and CO2 emissions, policymakers need to emphasize the negative effects of FDI. The empirical literature indicates that Southeast Asia countries must impose more stringent regulations to attain sustainable development strategies to attract investment in cleaner and more energy-efficient industries. These actions should relate to environmental, political, and social policies. Thus, the Southeast Asia region should consider enhancing a low-carbon energy system by applying various renewable energy sources, more efficient energy procedures, incentives, and regulatory mechanisms to appeal to clean investment and reduce environmental pollution.

Therefore, firstly, multinational companies would be encouraged to introduce new technology and refurbish existing installations to improve environmental performance by the host country's government. This suggests that FDI can enhance environmental management practices under a sustainable development context. Although the results show that FDI is attributed to lead to environmental pollution in Southeast Asia, the Halo effects theory cannot be completely rejected. The results of these studies suggest that FDI can be good for the environment as it offers new environmental approaches, such as the transfer of green technologies across borders. Multinational enterprises with environmentally friendly technology and practices should share their green know-how with countries with low-environmentally

friendly technologies. Therefore, governments can use the rising pace of globalization to help improve environmental conditions via channels of green FDI. Through FDI, domestic firms possibly have a chance to get access to the best, most efficient, and green technologies. Moreover, foreign firms are well-known for their detailed environmental impact assessment procedures and effective policies, resulting in better environmental conditions in the area.

Secondly, the results of this paper also suggest that Southeast Asia countries should not apply a one-policy-fits-environmental policy to deal with different types of pollutants as each pollutant has a distinguished impact level on the environment and different factors cause them. For example, CO2 emissions are caused by FDI inflow level, GDP growth, etc., while trade is the only contributor to the emissions of N2O. The differences in results could be because N2O is possibly a local pollutant based on geography, meaning that the variation in the level of N2O is affected regionally rather than globally. Therefore, countries should analyze each region to determine the main cause and impose appropriate policies. By contrast, CO2 is an international pollutant (Demena and Afesorgbor, 2020) and is less regulated locally. As a result, it requires mixed strategies in combating different pollutants. International environmental agreements should be paid more attention to and put into effect to deal with the global emission of CO2.

Moreover, the level of pollution varies among eleven countries in Southeast Asia, requiring appropriate regulatory policies for each country. For example, Indonesia contributes the most to the pollution level in the region, while Singapore is the least polluted. Therefore, to mitigate the effects of pollution, there should be mutual support from all members in Southeast Asia. Environmental policies must be country - and pollutant-specific to solve the nature of a country's environmental problem.

Thirdly, based on peer research such as Demena and Afesorgbor (2020) and Peres et al. (2018), the FDI inflows into developed countries seem to cause less pollution than FDI into developing countries. Therefore, developing countries should also implement stricter environmental policies with specific criteria to make sure that the inward FDI is environmentally friendly and this calls for mutual responsibility between developed and developing countries to ensure that the flow of FDI into developing countries similarly meets the high environmental standards as the one moving to developed countries.

Finally, to reduce pollution in Southeast Asia, the governments should strengthen the inspection and supervision of FDI activities and impose stricter environmental regulations. This means that regular monitoring and the reception of complaints and recommendations is also a source of information that needs to be expanded. Moreover, it is necessary to enhance transparency and democracy in the objective inspection, monitoring, evaluation, and publicity of the impacts of FDI on the environment.

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References

Afza, T., Nazir, M. S., (2007). Economic competitiveness and human resource development: An FDI perspective. *Pakistan Economic and Social Review*, 167-180.

Ansari, M. A., Khan, N. A. and Ganaie, A. A., (2019). Does foreign direct investment impede environmental quality in Asian countries? A panel data analysis. *OPEC Energy Review*, *43*(2), 109-135.

Asghari, M., (2013). Does FDI promote MENA region's environment quality? Pollution halo or pollution haven hypothesis. *International Journal of Research in Environmental Science*, *1*(6), 92-100.

Atici, C., (2012). Carbon Emissions, Trade Liberalisation, and the JapanASEAN interaction: A Group-wise Examination. *Journal of the Japanese and International Economies*, *26*(1), 167-178.

Barlow, R., (1994). Population growth and economic growth: Some more correlations. *Population and Development Review*, 153-165.

Borenstein, M., Hedges, L. V., Higgins, J. P. and Rothstein, H. R., (2010). A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research Synthesis Methods*, *1*(2), 97-111.

Chapuis-Lardy, L., Wrage, N., Metay, A., Chotte, J. L. and Bernoux, M., (2007). Soils, a sink for N2O? A review. *Global Change Biology*, *13*, 1–17.

Coale, A. J., Hoover, E. M., (2015). *Population Growth And Economic Development*. Princeton University Press.

Copeland, B. R., (2013). *Trade and the Environment*. In Palgrave handbook of international trade (pp. 423-496). Palgrave Macmillan, London.

Dauda, L., Long, X., Mensah, C. N. and Salman, M., (2019). The effects of economic growth and innovation on CO2 emissions in different regions. *Environmental Science and Pollution Research*, *26*, 15028-15038.

Demena, B. A., Afesorgbor, S. K., (2020). The effect of FDI on environmental emissions: Evidence from a meta-analysis. *Energy Policy*, *138*, 111192.

Dong, Y., Shao, S. and Zhang, Y., (2019). Does FDI have energy-saving spillover effect in China? A perspective of energy-biased technical change. *Journal of Cleaner Production*, *234*, 436-450.

Doytch, N., Uctum, M., (2016). Globalization and the environmental impact of sectoral FDI. *Economic Systems*, *40*(4), 582-594.

Du, L., Wei, C. and Cai, S., (2012). Economic development and carbon dioxide emissions in China: Provincial panel data analysis. *China Economic Review*, *23*(2), 371-384.

Eskeland, G. S., Harrison, A. E., (2003). Moving to greener pasture? Multinationals and the pollution haven hypothesis. *Journal of Development Economics*, *70*(1), 1–23.

French, H., (1998). Making private capital flows to developing countries environmentally sustainable: the policy challenge. In *Natural resources forum* (Vol. 22, No. 2, pp. 77-85).

Oxford, U.K.: Blackwell Publishing Ltd.

Fry, M. J., (1993). *Foreign direct investment in Southeast Asia: differential impacts*. Institute of Southeast Asian Studies.

Gill, F. L., Viswanathan, K. K. and Karim, M. Z. A., (2018). The critical review of the pollution haven hypothesis. *International Journal of Energy Economics and Policy*, *8*(1), 167-174.

Haisheng, Y., Jia, J., Yongzhang, Z. and Shugong, W., (2005). The impact on environmental Kuznets curve by trade and foreign direct investment in China. *Chinese Journal of Population Resources and Environment*, *3*(2), 14-19.

Harbaugh, W. T., Levinson, A. and Wilson, D. M., (2002). Reexamining the empirical evidence for an environmental Kuznets curve. *Review of Economics and Statistics*, *84*(3), 541-551.

Hoang, H., Bui, D., (2014). Determinants of foreign direct investment in ASEAN: A panel approach. *Management Science Letters*, *5*(2), 213-222.

Javorcik, B., (2012). *Does FDI bring good jobs to host countries?* World Bank.

Jugurnath, B., Emrith, A., (2018). Impact of foreign direct investment on environment degradation: evidence from SIDS countries. *The Journal of Developing Areas*, *52*(2), 13-26.

Khan, M. A., Ozturk, I., (2020). Examining foreign direct investment and environmental pollution linkage in Asia. *Environmental Science and Pollution Research*, *27*, 7244-7255.

Kheder, S. B., Zugravu, N., (2012). Environmental regulation and French firms location abroad: An economic geography model in an international comparative study. *Ecological Economics*, *77*, 48-61.

Lee, C. G., (2009). Foreign direct investment, pollution and economic growth: evidence from Malaysia. *Applied Economics*, *41*(13), 1709-1716.

Letchumanan, R., Kodama, F., (2000). Reconciling the conflict between the 'pollution-haven' hypothesis and an emerging trajectory of international technology transfer. *Research Policy*, *29*, 59–79.

Lin, P., Liu, Z. and Zhang, Y., (2009). Do Chinese domestic firms benefit from FDI inflow?: Evidence of horizontal and vertical spillovers. *China Economic Review*, *20*(4), 677-691.

Liu, W., Xu, X., Yang, Z., Zhao, J. and Xing, J., (2016). Impacts of FDI renewable energy technology spillover on China's energy industry performance. *Sustainability*, *8*(9), 846.

Liu, Q., Wang, Q., (2017). How China achieved its 11th Five-Year Plan emissions reduction target: A structural decomposition analysis of industrial SO2 and chemical oxygen demand. *Science of the Total Environment*, *574*, 1104-1116.

Llorca, M., Meunié, A., (2009). SO2 emissions and the environmental Kuznets curve: the case of Chinese provinces. *Journal of Chinese Economic and Business Studies*, *7*(1), 1-16.

Lopez, R., (1994). The environment as a factor of production: the effects of economic growth and trade liberalization. *Journal of Environmental Economics and Management*, *27*(2), 163-184.

Mahrinasari, M. S., Haseeb, M., Ammar, J. and Meiryani, (2019). Is trade liberalization a hazard to sustainable environment?: fresh insight from ASEAN countries. *Polish Journal of Management Studies*, *19*(1), 249-259.

Omri, A., Nguyen, D. K. and Rault, C., (2014). Causal interactions between CO2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. *Economic Modelling*, *42*, 382-389.

Peres, M., Ameer, W. and Xu, H., (2018). The impact of institutional quality on foreign direct investment inflows: evidence for developed and developing countries. *Economic research-Ekonomska Istraživanja*, *31*(1), 626-644.

Purcel, A. A., (2019). Does political stability hinder pollution? Evidence from developing states. *Economic Research Guardian*, *9*(2), 75-98.

Rajiani, I., Pypłacz, P., (2018). National culture as modality in managing the carbon economy in Southeast Asia. *Polish Journal of Management Studies*, *18*(1), 296-310.

Torras, M., Boyce, J. K., (1998). Income, inequality, and pollution: a reassessment of the environmental Kuznets curve. *Ecological Economics*, *25*(2), 147-160.

Unctad.org. 2020. [online] Available at: <https://unctad.org/en/PublicationsLibrary/wir2018_en.pdf> [Accessed 28 August 2020].

Unctad.org. 2020. Unctad.Org | Global Investment Flows Flat In 2019, Moderate Increase Expected In 2020. [online] Available at: <https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2274#:~:text=The%20United%20States%20remained%20the,and%20Singapore%20with%20%24110%20billion.> [Accessed 28 August 2020].

Ur Rahman, Z., Chongbo, W. and Ahmad, M., (2019). An (a) symmetric analysis of the pollution haven hypothesis in the context of Pakistan: a non-linear approach. *Carbon Management*, *10*(3), 227-239.

Vallero, D. A., (2016). Engineering aspects of climate change. In *Climate Change* (pp. 547-568). Elsevier.

Wheeler, D., (2002). *Racing to the bottom? Foreign Investment Air Pollution in Development Countries*. World Bank, Washington, DC.

World Bank Group (2020) *Interactive Data Access: Worldwide Governance Indicators, World Bank.* Available at: https://www.worldbank.org/en/publication/worldwide-governance-indicators/interactive-data-access (Accessed: 28 August 2020).

World development indicators (no date) DataBank. Available at: https://databank.worldbank.org/reports.aspx?source=world-development-indicators (Accessed: 28 August 2020).

Zarsky, L., (1999). Havens, halos and spaghetti: untangling the evidence about foreign direct investment and the environment. *Foreign Direct Investment and the Environment*, *13*(8), 47-74.

Zikmund, W. G., Carr, J. C., Babin, B. and Griffin, M., (2013) *Business research methods*. Nelson Education.

WPŁYW BEZPOŚREDNICH INWESTYCJI ZAGRANICZNYCH W POŁUDNIOWO-WSCHODNIEJ AZJI NA ZARZĄDZANIE ŚRODOWISKIEM: IMPLIKACJE DLA POLITYKI

Streszczenie: W niniejszym badaniu zbadano związek między zanieczyszczeniem środowiska mierzonym dwutlenkiem węgla (CO2), dwutlenkiem azotu (N2O) i bezpośrednimi inwestycjami zagranicznymi netto (BIZ), wraz z kilkoma innymi zmiennymi, a mianowicie: wzrostem gospodarczym według produktu krajowego brutto na mieszkańca, otwartością handlową, produkcją, stabilnością polityczną, urbanizacją i wzrostem liczby ludności, wykorzystując roczne dane 11 krajów z Azji Południowo-

Wschodniej za okres od 1999 do 2019 roku. Po przetestowaniu przydatności modelu efektów stałych i losowych, w niniejszym badaniu wykorzystano ten pierwszy. Wyniki pokazują, że napływ bezpośrednich inwestycji zagranicznych powoduje wzrost poziomu CO2 w Azji Południowo-Wschodniej, co potwierdza teorię nieba zanieczyszczeń. Jednak jeśli chodzi o poziom N2O, wynik nie jest znaczący, co oznacza, że nie ma związku między napływem BIZ a poziomem N2O. Inne zmienne, w tym PKB i otwartość handlowa, również negatywnie wpływają na środowisko w Azji Południowo-Wschodniej. Przedstawiono również pewne zalecenia dla rządu Azji Południowo-Wschodniej w celu poprawy stanu środowiska w tym regionie.

Słowa kluczowe: Bezpośrednie inwestycje zagraniczne, zanieczyszczenie środowiska, wzrost gospodarczy