Wahyudi, Heru; Suripto, Suripto; Palupi, Widia Anggi

Article

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Long-Term Implications of Economic Complexity and Energy Intensity on the Environment in Lower-Middle-Income Countries in Asia

Heru Wahyudi*, Suripto, Widia Anggi Palupi

University of Lampung, Bandar Lampung, Indonesia. *Email: heru.wahyudi@feb.unila.ac.id

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ABSTRACT

This study aims to determine the long-term impact of Foreign Direct Investment (FDI), Population (POP), Economic Complexity Index (ECI), and Energy Intensity (EI) on environmental quality as measured by carbon dioxide (CO_2). The objects of this research are lower-middle income countries in the Asian region during the 2000-2018 range. The method used in this research is a Fully Modified Ordinary Least Square (FMOLS). The results of this study indicate that FDI, population, economic complexity, and energy intensity increase the amount of CO_2. These results produce policies related to the environment, where the government, the private sector, and the community have the same vision to improve the quality of the environment. The policy that can be taken is by setting strict regulations for investors so that the pollution haven hypothesis does not occur in lower-income countries in Asia. The policy was adopted by imposing a carbon tax. This policy is accompanied by reducing the birth rate, increasing innovation and economic complexity by paying attention to environmental sustainability, as well as carrying out energy transformation. Thus, it is expected to reduce the spread of CO_2 that lower-middle-income countries are ready to become upper-middle-income countries or even high-income countries.

Keywords: CO_2, Economic Complexity, Energy Intensity, FMOLS
JEL Classifications: Q4, Q5, O1

1. INTRODUCTION

Asia is the largest and most diverse continent in the world (Chapman, 2022). Asia is growing in the world economy and its contribution to growth, the slowdown in Asia further reduces the outlook for the global economy. Estrada et al. (2017) so it can be seen that Asia is one of the continents that has a major contribution to the global economy. Gross National Income (GNI) is one indicator to see the economic condition of a country. The World Bank classifies a country's economy based on its income, namely: lower income, lower-middle income, upper-middle income, and high income.

Lower-middle-income countries in the process of industrialization and urbanization face greater challenges in environmental protection and public health promotion (Shi, 2022). Middle-income countries are classified as developing countries. Research Adirini (2012) found that food production in developing countries is still very dependent on the natural environment, causing environmental damage in the region. Amid environmental problems faced as the largest region, Asia is also the continent with the most populous population. Areas with a dense population will make space increasingly narrow, residents cannot be separated from the environment, causing environmental exploitation (Akhirul et al., 2020). Environmental damage since the global crisis has led to slower Asian growth (Estrada et al., 2017). Research from Candra, (2018); Khezri et al. (2022); Widyawati et al. (2021) used a carbon dioxide (CO_2) indicator to measure the environmental quality of an area.

In addition to the population of an area, research by Wang and Huang, (2022); Xie et al. (2020) found that foreign direct investment (FDI) has an influence on environmental quality. According to study by (Wang and Huang, 2022) severe energy environmental management and control laws are typically implemented in developed countries; as a result, polluting corporations frequently relocate their facilities to underdeveloped regions with lax environmental regulations. FDI harms the environment as a result. Production skills, according to Ricardo Hausmann and Cesar Hidalgo's 2009 argument, are all the inputs, technologies, and concepts that collectively set the limitations of what an economy can produce. Hausmann and Hidalgo suggest using an alternative metric called the Economic Complexity Index to gauge the potential for the Economic Complexity Index (ECI).

The degree of economic complexity provides a comprehensive picture of the magnitude, structure, and technological progress of a country Doğan et al. (2019) it not only demonstrates a nation's capabilities but also the diversity of its product offerings. Some studies examine the impact of economic complexity on environmental quality. There hasn't been a lot of research, though, on how the economic complexity variable affects CO_2 in lower-middle income Asian nations. According to research by Khezri et al. (2022) as economic complexity rises, environmental quality will decline, which will result in an increase in CO_2. Nevertheless, He et al. (2021) showed that economic complexity can reduce economic pollution.

In addition to population, FDI, and economic complexity, there are other factors that affect the quality of the environment. Based on research conducted by Shahbaz et al. (2015) found that energy intensity has an effect on improving environmental quality. Research from Kartiasih et al. (2012) shows that energy plays a very important and strategic role in people's lives because energy is an indicator of a country's development and economic growth. However, the energy required has a negative impact on environmental quality. If this continues to be ignored, it can have a negative impact on the long-term welfare of a country.

Asia is the continent that provides the highest CO_2 emissions, as shown in Figure 1. Global warming is a significant environmental problem that has led to seasonal changes and harsh weather in several parts of the world (Widyawati et al., 2021). A rise in greenhouse gases, such as carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), and gases containing fluorine, is what causes global warming (HFCs, PFCs, and SF6). The majority of the rise in greenhouse gases 75% was caused by carbon dioxide (CO_2) emissions (Abbasi and Riaz, 2016). According to study by Ardhitama et al., (2017) greenhouse gases make the world hotter by trapping lower-middle-income brought on by human activity.

The concept of sustainable development is a development concept in the field of environmental management the increase on the concern of world countries towards the emergence of environmental damage and pollution which is increasingly worrying about the sustainability of the function of environmental sustainability and its carrying capacity for the interests of present and future generations (Mukhlish, 2016). Sustainable development demands a good environmental system with an increasing rate of economic growth from time to time. This condition is in contrast to most countries in the Asian continent who want economic growth at the expense of the environment, causing environmental degradation (Shittu et al., 2021). The main objective of this study is to evaluate the effect of foreihuulation, economic complexity, and energy intensity on environmental conditions in low-middle-income Asian countries. Indicators of environmental conditions in this study using the variable carbon dioxide (CO_2). This study presents a literature review to support the methodology that will be applied to the results analysis and discussion. Thus, this article shows some conclusions that can be used as recommendations for economic policy makers, especially for lower middle-income countries in Asia.

2. LITERATURE REVIEW

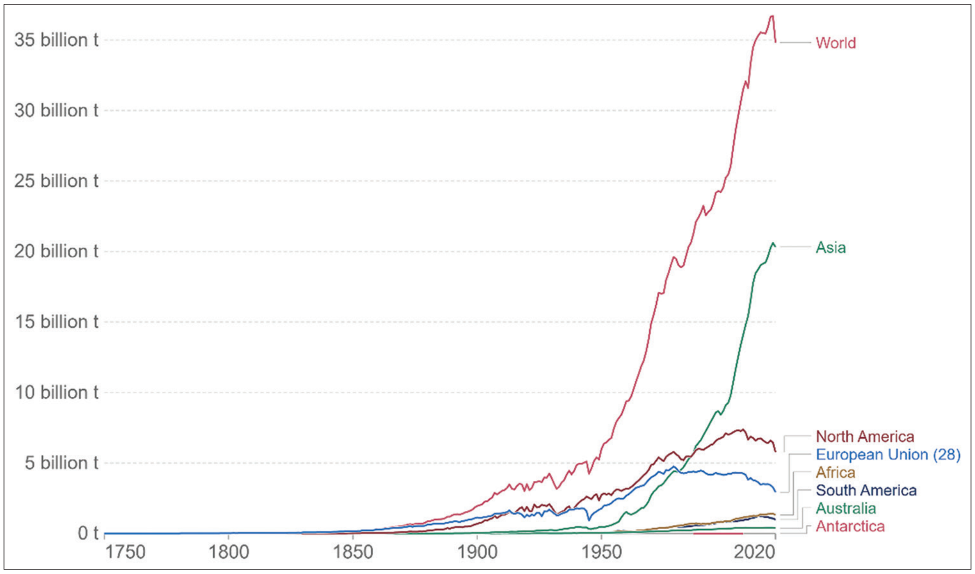
The relationship between foreign direct investment, population, economic complexity, energy intensity, and CO_2 emissions is discussed in this section based on a recent literature review survey. Since the second generation of environmental challenges in the 1980s, a thorough and systematic research of the coordinating link between energy, environment, and economy has become significant and urgent. Lower-middle income nations are categorized as developing nations, and developing nations frequently struggle with a shortage of cash.

According to the Harrod-Domar theory, to achieve a stable economy in the long term, investment is needed Marselina (2020) Along with the development of technology and transportation, foreign direct investment is getting easier and faster to do. Although FDI can stimulate economic growth, it also has an impact on the environment. To attract foreign investment, developing countries tend to ignore environmental problems through loose regulation; in economic theory this phenomenon is called the "pollution haven hypothesis" (Zhu et al., 2016). Research conducted by Wang and Huang (2022) found that FDI increases environmental damage in developing countries. Thus the research conducted by Wang and Huang (2022) shows the pollution haven hypothesis.

Using the Autoregressive Distributed Lag (ARDL) method, research from Gunarto (2020) titled "Effect of economic growth and foreign direct investment on carbon emission in the asian states" found that FDI was not significant, indicating uncertainty about whether FDI will be the cause of the increase in carbon dioxide gas emissions or not. For Asian nations that must concentrate on energy consumption to produce carbon emissions and harm the environment, the variable FDI's negligibility is suitable Gunarto (2020) the findings of this study are different from those of a study by Huang et al. (2019), which discovered that FDI had a negative and significant impact on CO_2 emissions in China, with the exception of the 5^{th} and 10^{th} quantiles. The halo effect theory is well supported by research by Huang et al. (2019) in China with medium and high emissions.

Research conducted by Huang et al. (2019) contradicts research conducted by Wang and Huang (2022) entitled "Impact of Foreign Direct Investment on the Carbon Dioxide Emissions of East Asian Countries Based on a Panel ARDL Method" with the ADRL method. The results of his research found that foreign direct

Figure 1: Annual CO_2 emissions



Source: Our world in data

investment had a positive effect on CO_2; foreign investors have more advantageous knowledge advantages, including production technology, management and organizational skills, sales skills and other intangible assets, and enterprise-scale monopolistic advantages and others, thereby obtaining more benefits from overseas production as well as policies and strict management and control of the energy environment are generally applied in developed countries (Wang and Huang, 2022). So that developing countries become the target of foreign investors to increase profits and loose environmental regulations.

Environmental damage is also influenced by population. In a study conducted by Lawal (2019) entitled "Impact of population growth on Carbon Dioxide (CO_2) emission: empirical evidence from Nigeria" using the Ordinary Least Square (OLS) method, it was found that the population had a positive effect on CO_2. This means that more and more population causes an increase in environmental damage. Various kinds of human activities such as bush burning, animal husbandry, deforestation, increasing the number of vehicles, increasing the use of generators, and so on; besides that, there is also industrial activity that causes a greater amount of CO_2 (Lawal, 2019).

Research Mohammadi et al. (2020) entitled "Impact of Population and Economic Growth on CO_2 Emission (Case of Afghanistan)" supports research (Lawal, 2019)**.** According to the findings, a 1% increase in population would result in a 0.32% increase in CO_2. In accordance with Mohammadi et al. (2020), an increase in population raises the consumption of fossil fuels and natural gas, which directly raises CO_2 levels; an increase in population also increases demand for goods and services, which can raise GDP and raise household income, both of which have an impact on the amount of CO_2 in the atmosphere.

In addition to population growth and FDI, a study by Khezri et al. (2022) examined the impact of economic complexity on CO_2 in 29 Asia-Pacific nations. In a study titled "Environmental implications of economic complexity and its role in determining how renewable energies affect CO_2 emissions" Khezri et al. (2022) it was discovered that as economic complexity rises, environmental quality declines, which is indicated by an increase in CO_2. According to a study by Khezri et al. (2022), an increase in energy output and consumption might cause environmental degradation as economic complexity rises. This study is supported by research from Neagu (2019), which discovered that economic complexity has an effect on pollution in the early stages of export activities because resources are used widely to maintain export products. However, after a certain point, economic complexity is able to produce pollution reduction because resources and technology that produce less pollution are used. This is particularly true for low-income nations whose economies are reliant on natural resources.

Everyone and every business needs to consume energy. In this study, energy intensity is used to examine the impact on CO_2. Energy consumption as a percentage of GDP is a measure of a country's energy efficiency; the lower the energy intensity number, the more effectively that country uses its energy resources Kementerian Energi dan Sumber Daya Mineral (2015). According to research by Danish et al. (2020), "Environmental implications of economic complexity and its role in determining how renewable energies affect CO_2 emissions" an increase in energy intensity can lead to an increase in pollution, which is represented by an increase in CO_2; in 25 European Union countries, a 10% increase in energy intensity can result in an increase of 3.72–3.93% CO_2. According to research Vitenu-Sackey and Acheampong (2022), rising energy intensity to raises CO_2 in 18 developed countries, this study is supported. . ÖZTÜRK and ÖZ (2016) (2016) also discovered that higher CO_2 emissions from energy use contribute to environmental damage.

3. RESEARCH METHODS

Data on carbon dioxide (CO_2), foreign direct investment, population, the economic complexity index, and energy intensity were used in this study as secondary data. The World Bank provided information on CO_2, foreign direct investment, population, and energy intensity; The Atlas Economic provided information on economic complexity. In this study, CO_2 is the dependent variable, and FDI, population, economic complexity, and energy intensity are the independent factors. Lower-middle-income Asian nations, including Bangladesh, Cambodia, India, Indonesia, Iran, the Kyrgyz Republic, Laos, Mongolia, Myanmar, Pakistan, Philippines, Tajikistan, Uzbekistan, and Vietnam, are the focus of this study. Panel data is the type of data used, and 15 cross-sections of lower middle-income nations in Asia are used based on the World Bank's 2021 criteria. The time series spans 18 years, from 2000 to 2018, and the data is organized into a panel. A fully modified ordinary least squares (FMOLS) panel was the study technique used. To examine the long-term impact of independent factors on the dependent variable, use the FMOLS approach (Saragih et al., 2021).

Panel data that is non-stationary and heterogeneous among panel members is employed using the FMOLS approach, which may result in erroneous regressions with no real economic relevance (Pedroni, 2000)**.** The dependent variable and the independent variable, which must be non-stationary at the level and have a cointegration connection between the variables, are required for FMOLS estimation. After that, the FMOLS test can be run. FMOLS offers a consistent test of the general cointegration vector value under the null hypothesis to the cointegration vector value that is not necessarily common under the alternative hypothesis, in contrast to the estimators gathered in the dimensions (Pedroni, 2000)**.** The model can be summarized as follows.

$$LNCO_{2it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 LNPOP_{it} + \beta_3 ECI_{it} + \beta_4 EI_{it} + \varepsilon_{it} \quad (1)$$

Where $LNCO_2$ is the natural logarithm of CO_2, FDI is Foreign Direct Investment, LNPOP is the natural logarithm of the population, ECI is the Economic Complexity Index, EI is the energy intensity, β_0 is a constant, $\beta_{1,2,3,4}$ is the coefficient, i is the cross section (15 Asian lower-middle income countries, t is the time series 2000-2018), and ε is the residual.

Data stationarity is the initial prerequisite. In order to guarantee that the data utilized in this study are stationary data and to prevent erroneous regression between the dependent variable and the independent variable, the panel unit root test is used (Widarjono, 2018). Levin, Lin, and Chu (LLC) and Breitung's test statistics make up the common unit root, while Im, Pesaran, and Shin (IPS) test statistics make up the individual unit root; other tests used to test the unit root panel include the ADF-Fisher test and the Phillips Perron (PP)-Fisher test (Gujarati, 2009). According to the following equations, H_0: $\alpha_i = 0$ for all I (there is a unit root, but it is not stationary), and H_a: $\alpha_i \neq 0$ (there is no unit root, it is stationary). The decision is if the probability value is smaller than the significance level, then it fails to reject H_a.

The cointegration test is used for the second condition. Finding out whether there might be a long-term equilibrium relationship between the variables to be examined is the main goal of the idea of cointegration (Sekaran et al., 2017)**.** One test that can be used to determine whether a number of variables are cointegrated is Johansen's test (Widarjono, 2018). This test is performed following the stationary test because the observed variables must first be examined for cointegration to see whether they are integrated with one another or have a long-term relationship. The following is the cointegration test's derived hypothesis: H_0: The variables do not exhibit cointegration and H_a the variables exhibit cointegration. After all the tests meet the requirements, the FMOLS estimation is carried out.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistical Analysis

To explain the results of the research object, one of them can use descriptive statistical analysis. The descriptive statistics consist of the average value (mean), the smallest value (minimum, and the highest value (maximum) as indicators in explaining the spread of data on the variables used in the study. The following is a table of descriptive statistical analysis in this study.

Based on Table 1, it is known that the mean, minimum value, and maximum value of the variables CO_2, FDI, population, economic complexity, and energy consumption. The average value of environmental damage as a proxy for carbon dioxide (CO_2) is 207.393 kt. Countries with above-average CO_2 are India, Iran, and Indonesia. Countries with below-average CO_2 are Pakistan, Vietnam, Uzbekistan, Philippines, Bangladesh, Sri Lanka, Mongolia, Myanmar, Kyrgyz Republic, Cambodia, Laos, and Tajikistan. The highest carbon dioxide among Asian lower-middle income countries during 2000-2018 was India 2018 which was 2,451,930 kt. While the lowest carbon dioxide was in Laos in 2000 which was 900 kt.

Furthermore, regarding the foreign direct investment (FDI) variable, the average value of FDI in lower-middle-income Asia is 3.469946%. Countries with above-average FDI are Mongolia, Cambodia, Kyrgyz Republic, Vietnam, Tajikistan, Laos, and Myanmar. Meanwhile, countries with below-average FDI are India, Uzbekistan, the Philippines, Sri Lanka, Indonesia, Pakistan, Bangladesh, and Iran. The country with the highest FDI during the 2000-2018 range in lower-middle income Assia was Mongolia at 43,91211% in 2011 and the lowest FDI was also in Mongolia in 2016 at −37,17265%.

The average population value (POP) in lower-middle-income Asia is 144,000,000 people. Countries with above-average populations are India, Indonesia, Pakistan, and Bangladesh. While countries with below-average populations are the Philippines, Vietnam, Iran, Myanmar, Uzbekistan, Sri Lanka, Cambodia, Tajikistan, Laos, Kyrgyz Republic, and Mongolia. The highest population among lower-middle-income Asian countries during the 2000-2018 range is India, which is 1.35 million people in 2018. Meanwhile, the country with the lowest population is Mongolia, which was 2,397,417 people in 2000.

The average value of economic complexity (ECI) in lower-middle-income Asia is –0.468342. Countries with above-average economic complexity are the Philippines, India, Indonesia, the Kyrgyz

Table 1: Descriptive Statistical Analysis

Descriptive Statistical	CO_2	FDI	POP	ECI	EI
Mean	207392.7	3.469946	144,000,000	–0.46834	6.04
Median	44750	2.002066	50250366	–0.54015	5.2
Maximum	2451930	43.91211	1,350,000,000	0.958651	31.0
Minimum	900	–37.17265	2397417	–1.36886	1.8
Std. Dev.	421122.3	5.337826	295,000,000	0.497176	4.225094
Skewness	3.319858	1.308831	3.200252	0.430926	3.451826
Kurtosis	14.53658	29.35886	12.02779	2.48874	17.96782
Jarque-Bera	2103.994	8331,997	1454,301	11.9246	3226.39
Observations	285	285	285	285	285

Source: EViews 10 (2022)

Republic, Vietnam, and Sri Lanka. Meanwhile, countries with below-average economic complexity are Uzbekistan, Pakistan, Iran, Cambodia, Bangladesh, Laos, Myanmar, Tajikistan, and Mongolia. The most complex export basket in lower-middle-income Asian countries is the Philippines at 0.958651 in 2016, while the lowest is Mongolia at –1.36886 in 2010.

Furthermore, the average value of energy intensity (EI) in lower-middle-income Asia is 6.040000. Countries with energy intensity above the average are the Philippines, India, Indonesia, Kyrgyz Republic, Vietnam, and Sri Lanka. Meanwhile, countries with below-average energy intensity are Uzbekistan, Pakistan, Iran, Cambodia, Bangladesh, Laos, Myanmar, Tajikistan, and Mongolia. The country with the highest use of energy intensity was Uzbekistan in 2000, which was 31. While the country with the highest use of energy intensity was Sri Lanka, which was 1.8 in 2018.

4.2. Stationarity Test

To prevent erroneous regression between the independent and dependent variables, the unit root test panel seeks to guarantee that the data utilized in the study are stationary power (Widarjono, 2018). Non-stationary variables, in particular situations where the estimation results show a significant regression coefficient and a high coefficient of determination but the relationship between the independent variable and the dependent variable is not interconnected or not cointegrated, according to Ekananda (2016), will result in false estimates. In this work, an individual unit-root test employing the Augmented Dickey-Fuller (ADF) method was used as the unit-root panel test. The test table for the unit-root panel test utilizing the ADF method is shown below.

Table 2: Unit-root panel test

Unit-Root Panel Test Method	Intercept		Intercept and trend	
	Level	1st different	Level	1st different
$LOGCO_2$				
LLC	0.3920	0.0000*	0.2650	0.0009*
Breitung			0.9305	0.0005*
IPS	1.0000	0.0000*	0.6943	0.0002*
ADF-Fisher	1.0000	0.0000*	0.3999	0.0008*
PP-Fisher	0.9994	0.0000*	0.5986	0.0000*
FDI				
LLC	0.0078*	0.0000*	0.0594	0.0000*
Breitung			0.0074	0.0024*
IPS	0.0054*	0.0000*	0.1229	0.0000*
ADF-Fisher	0.0089*	0.0000*	0.1742	0.0000*
PP-Fisher	0.0001*	0.0000*	0.0461 *	0.0000*
LNPOP				
LLC	0.3070	0.0000*	0.0000 *	0.0000*
Breitung			1.0000	0.6041*
IPS	1.0000	0.0000 *	0.0000 *	0.0000*
ADF-Fisher	0.2526	0.0000 *	0.0000 *	0.0000*
PP-Fisher	0.0000*	0.0236*	0.0029 *	0.8952*
ECI				
LLC	0.0467*	0.0000*	0.0615	0.0002*
Breitung			0.344	0.0011*
IPS	0.0985	0.0000*	0.2869	0.0000*
ADF-Fisher	0.1685	0.0000*	0.1184	0.0000*
PP-Fisher	0.0079*	0.0000*	0.0056	0.0000*
EI				
LLC	0.0006*	0.0000*	0.8232	0.0000*
Breitung			1.0000	0.0024*
IPS	0.5994	0.0000*	0.9842	0.0000*
ADF-Fisher	0.4451	0.0000*	0.7044	0.0001*
PP-Fisher	0.0005*	0.0000*	0.1604	0.0000*

*Significant to 5%

Based on Table 2, it can be seen that all variables are stationary at the first different level. This is evident from the fact that each variable included in the study has a probability value that is ≤0.05. The cointegration test can therefore be used to continue this test.

4.3. Cointegration Test

Finding out whether there might be a long-term equilibrium relationship between the variables to be examined is the main goal of the idea of cointegration (Sekaran et al., 2017). The Johansen Fisher Panel Cointegration Test methodology is used in this work. When a probability value is produced, an equation is said to be cointegrated. Maximum values include At most 1, At most 2, At most 3, and At most 4 as long as there is no integration between variables if the probability value is greater than 0.05. Conversely, cointegration between the variables exists if the probability value is smaller than 0.05.

In Table 3 it can be seen that the probability value of the cointegration test is 0.0000 which is smaller than the α value of 0.05%. Because of this, it can be said that all of the variables examined in this study are cointegrated or have a long-term relationship based on this value. The analytical tool employed is FMOLS panel data analysis, which is based on the outcomes of the data stationarity test and cointegration test (Fully Modified-OLS Test).

4.4. Fully Modified-OLS (FMOLS) Test

FMOLS panel analysis is used to see the long-term impact of foreign direct investment variables, population size, economic complexity, and energy intensity that can affect carbon dioxide (CO_2). According to Hong and Wagner (2011), after the two conditions consisting of the stationarity test and cointegration test are met, the FMOLS method can be used in panel data analysis. The following are the estimation results using the FMOLS method.

Based on Table 4, the FMOLS test shows that the t-statistics for foreign direct investment (FDI), population (LNPOP), economic complexity index (ECI), and energy intensity (EI) variables are respectively 3.197877, 12.68803, 2.317781, and 5.214001, respectively, greater than the t-table value is 1.650624 besides that the probability value is smaller than the significance level of 0.05 which means it has a significant effect on the variable carbon dioxide (CO_2). Other than that, the probability value is below the 0.05 level of significance, indicating that it significantly affects the carbon dioxide (CO_2) variable. The study's regression coefficient (R^2) is 0.985569, which means that the variables foreign direct investment, population, economic complexity, and energy intensity can affect the variable carbon dioxide (CO_2) 98.5569% of the time, with other variables outside the model accounting for the remaining 1.4431% of the time.

5. DISCUSSION

From the results of our study, we found interesting findings, where foreign direct investment, population size, economic complexity, and energy intensity led to an increase in environmental degradation as indicated by an increase in carbon emissions (CO_2) in 15 low-middle income countries in Asia in 2000-2018. The results show that when FDI increases by 1%, CO_2 increases by 1.56% in the long run, cateris paribus. These results are in accordance with the hypothesis that is in accordance with the object of research and is in line with the research conducted by (Wang and Huang, 2022; Xie et al., 2020). This finding identifies that in the lower middle-income countries in Asia there is a pollution haven hypothesis (PPH). From the PHH point of view, strict environmental regulations in developed countries lead to the relocation of polluting industries from developed countries to developing countries and lead to increased pollution in developing countries (Gill et al., 2018).

Table 3: Johansen fisher panel cointegration test

Hypothesized No. of CE (s)	Fisher stats.* (from trace test)	Prob.	Fisher Stats.* (from max-eigen test)	Prob.
None	674.8	0.0000	481.8	0.0000
At most 1	377.7	0.0000	234.9	0.0000
At most 2	193.0	0.0000	129.9	0.0000
At most 3	104.2	0.0000	80.45	0.0000
At most 4	77.51	0.0000	77.51	0.0000

Source: Eviews (2022)

Table 4: FMOLS test results

Variable	Coefficient	SE	t-Statistic	Prob.
FDI	0.015600	0.004878	3.197977	0.0016
LNPOP	4.373577	0.344701	12.68803	0.0000
ECI	0.285712	0.123270	2.317781	0.0213
EI	0.063941	0.012263	5.214001	0.0000
R-squared	0.985569	Mean dependent var		10.65562
Adjusted R-squared	0.984534	SD dependent var		1.938535
SE of regression	0.241080	Sum squared resid		14,58799
Long-run variance	0.125352			

Source: EViews (2022)

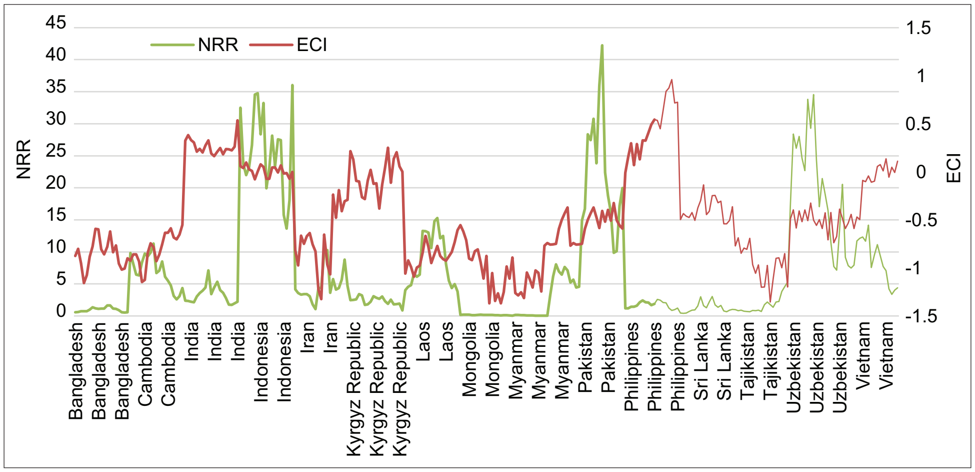
The results of the population variable test show that when the population increases by 1%, CO_2 will increase by 4.373577% in the long term, cateris paribus. This result is in line with the hypothesis and with the research conducted by (Akhirul et al., 2020; Lawal, 2019; Mohammadi et al., 2020). The number of populations that have a positive effect on increasing environmental degradation is the object of this study, where middle to lower-income countries in Asia are countries with the most populous populations in the world such as India, Indonesia, Pakistan, and Bangladesh, which are included in the eight countries in the world according to (World Population Review, 2022). Population growth tends to encourage massive economic activity due to the higher demand for goods and services (Perwithosuci et al., 2020). The increase in population ultimately increases the number of the workforce Todaro (2006) can attract foreign investors to invest because it has a young and cheap workforce. The increasing population coupled with poor environmental policies exacerbates environmental conditions in lower-middle-income countries in Asia.

The results of the economic complexity variable test show that an increase in economic complexity by 1 point will increase CO_2 by 28.5712% in the long run, cateris paribus. The results of this study are in line with research conducted by (Khezri et al., 2022; Neagu, 2019). Research from Laverde-Rojas et al. (2021) states that economic complexity has a correlation with future economic growth. Economic complexity is measured by the diversity of a country's export basket. Meanwhile, Asia's lower middle-income countries still depend on the primary sector and do not yet have a large value-added value. This causes the economic complexity in lower-middle-income countries to tend to be lower than in upper-middle-income countries.

The low index of economic complexity and its dissociation with environmental degradation is related to the trade balance deficit (Laverde-Rojas et al., 2021). While research from Santra (2017) CO_2 can decrease with high technological innovation. The case that occurred in lower-middle-income countries in Asia is that they have not been able to optimize the complexity of the economy, which has an impact on environmental damage. Lower-middle-income countries tend to export natural resources. The contribution of the natural resources sector to a country's economic growth can be measured by natural resources rent. The following is data on natural resources rent (NRR) and economic complexity in low-middle-income countries in Asia from 2000-2018.

According to Figure 2, the economic complexity index of Asia's middle-income and lower-income countries is still quite low when compared to the contribution of natural resources to economic growth. Conditions in lower-middle-income nations are adversely correlated with those in high-income nations, where a sophisticated economy can slow down environmental degradation. This is

Figure 2: Economic Complexity Index and Natural Resources Rents in Low-Middle-Income Countries Asia



Source: World Bank, Processed Data (2022)

supported by research by Doğan et al. (2019)**,** which discovered that while economic complexity lowers carbon emissions in high-income nations, it increases carbon emissions in low-and middle-income countries. According to Doğan et al. (2019) research, it was determined that: "At the development stage, developing countries tend to focus on less sophisticated products so that they have an impact on environmental degradation. For example, lower-middle-income countries prioritize agricultural products over the textile sector in the early stages of industrialization, where the textile sector is more complex and polluting than the agricultural sector; in the process, the products produced are more sophisticated and have an impact on economic growth."

Additionally, the energy intensity variable demonstrates that, cateris paribus, when the energy intensity rises by 1 point, the long-term increase in CO_2 will be 6.3941%. This result is consistent with the theory and investigation made by (ÖZTÜRK and ÖZ, 2016; Shahbaz et al., 2015; Vitenu-Sackey and Acheampong, 2022). Not only do people need energy, but also major industries need energy in their manufacturing processes. Asia's lower-middle-income nations have not used sustainable energy for their energy needs. Energy consumption plays a significant role in the development of the Southeast Asian economy Fachrul (2011) Southeast Asian nations with lower-middle incomes include Indonesia, Cambodia, Myanmar, the Philippines, Laos, and Vietnam.

Middle- and lower-income Asian nations should concentrate more on investing in renewable energy sources like hydro and solar to improve the quality of the environment. Studies from Shittu et al. (2021) to fully utilize the hydropower potential of Asian economies, measures are needed. The research of Shukla et al. (2017) which discovered that the Asian economy is geographically located in areas with different climatic conditions, such as tropical, humid, and so on, provides easy access to various renewable energy sources, demonstrates the enormous potential of Asia to use renewable energy.

6. CONCLUSION

FDI, population, economic complexity, and energy intensity significantly increase environmental degradation through long-term CO_2 variables in 15 lower-middle-income countries. The government, the private sector, and the community should have one vision to reduce environmental degradation. Governments in lower-middle-income countries increase regulations in the field of investors by paying more attention to and implementing relevant regulations, especially those related to carbon taxes. Naturally, this results in a rise in economic complexity to manufacture cutting-edge, ecologically friendly products that can continue to draw in investors without harming the environment. In addition, it is also important to provide education to the community to reduce birth rates and create family planning programs to produce a generation that can contribute to the economy by prioritizing environmental quality. And the government cooperates with the private sector to carry out energy transformation, with the geographical location of Asian countries certainly having the opportunity to realize renewable energy so that it can reduce the use of energy that can damage the environment. By putting in place a program to make it easier for children who are not in school to obtain education and training, efforts are being made to increase the quality of human resources.

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