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An Empirical Investigation between FDI, Tourism, and Trade on CO_2 Emission in Asia: Testing Environmental Kuznet Curve and Pollution Haven Hypothesis

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ABSTRACT

This study aims to analyze the influence of foreign direct investment (FDI), tourism, exports, and imports on carbon dioxide (CO_2) emissions in the High-Income State, Upper-Middle Income, and Lower-Middle-Middle Income in Asia during the period of 2010-2019. This study uses the Poisson Pseudo-Maximum Likelihood method. The results of this study indicate that Environmental Kuznets Curve Hypothesis is valid in the country of High Income and Upper-Middle Income. In addition, there is a non-linear relationship between FDI, tourism, Export, and imports on carbon dioxide (CO_2) emissions. The interaction variables, which are a FDI with tourism and FDI with Export. Each of them is reducing carbon dioxide emissions only in high-income countries. Meanwhile, the interaction variables between FDI and imports reduce carbon dioxide emissions in high-income countries. However, it increases the carbon dioxide emissions in the upper-middle-income country.

Keywords: Carbon Dioxide Emissions, Export, Foreign Direct Investment, Import, Poisson Pseudo-Maximum Likelihood, Tourism
JEL Classifications: Q4, Q5

1. INTRODUCTION

As the scale of globalisation are increasing in the past several decades, the existing of global warming are currently become the hot topics to discuss all economic actor namely among policy maker, researcher, academics and private sector (Liu et al., 2022). Global warming is a phenomenon of increasing carbon dioxide (CO_2) emissions caused by several factors, both natural factors and human factors, such as combustion activities; activities in the industrial sector; transportation; Forest fires; Until other economic activities (Neves et al., 2020; Purnawan et al., 2015; Salari et al., 2021). The impact of the increase in CO_2 emissions is to cause an increase in the temperature of the earth, the melting of glaciers and ocean ice, change the rainfall patterns, and cause animal movements (Mazur et al., 2015). CO_2 emission relations with the economy are explained through the Environmental Kuznets Curve (EKC) or Kuznets environment curve (Le et al., 2020; Taguchi, 2013).

Increasing economic activity, in turn, causes environmental damage. If environmental damage can be controlled, economic growth will stop at a point or limit because the damage to the environment will be much larger and destroy human lives as well as the earth. High economic performances in countries can be an interesting main attraction for the flow of foreign direct investment (FDI). Thus, could promote higher national output and as well as High economic growth is also due to the flow of FDI (Copeland and Taylor, 2004; Dogan and Seker, 2016). However, there are

two opposing arguments regarding the relationship between FDI and environmental. Pollution Haven Hypothesis (PHH) confirms that different environmental regulations among countries influence the location of the company's location or industry, while Halo Hypothesis pollution focuses on the environmental performance of foreign companies compared to domestic partners rather than industrial locations (Balsalobre-Lorente et al., 2019; Danish et al., 2021; Dauda et al., 2021; Gyamfi et al., 2021; Jensen, 2021; Li et al., 2022; Liu et al., 2019). This argument indicates that the inflow of FDI by multinational companies tends to improve environmental standards in developing countries, bringing cleaner technology and a better environmental management system (Seker et al., 2015).

Meanwhile, there are several sectors that also responsible for reducing environment quality. Several studies already successfully confirm that environmental degradation, tourism and international trade have strong connection (Gössling et al., 2015; Liu et al., 2019; Lu et al., 2019; Z. Tang et al., 2014). The tourism sector has linkages to energy and environmental consumption, depending on the source of energy use, such as renewable and non-renewable energy the tourism sector. It can reduce or increase pollution. The impact of tourism on the environment may differ through supporting policies and government intervention for low emissions and the use of net technology in the sector (Liu et al., 2019; Lu et al., 2019). While, international trade can also cause environmental damage. Through international trade, developed countries adopted environmental regulations to relocate energy-intensive companies to Asia, one of which is to China (Antweiler et al., 1998; Du et al., 2020; Essandoh et al., 2020; Jijian et al., 2021; Le et al., 2016). This causes environmental problems to become more serious in the Asian region.

Based on the background that has been described, CO_2 emissions cannot be separated from FDI, the tourism sector, Export, and imports. These factors can increase the per capita income of a country so that the economic growth of a country will increase. This study aims to find out and analyze how the influence of FDI, tourism, Export, and imports. The study also examines interactions between variables, namely FDI with tourism, FDI with exports, and FDI with imports on carbon dioxide emissions (CO_2) in the country of High Income, Upper-Middle Income, and lower-middle-income in Asia during 2010-2019.

2. THEORETICAL BASIS AND DEVELOPMENT OF HYPOTHESES

The theoretical basis of this research relies on Environmental Kuznet Curve Hypothesis, Pollution Haven Hypothesis, Pollution Halo Hypothesis and Heckscher-Ohlin Theory. EKC is a hypothesis build by Kuznets on 1955. This hypothesis explains the relationship between economic growth towards the environment. This hypothesis explains that the economy is able to improve environmental damage caused by economic activity in the long run. The EKC hypothesis shows that economic growth can cause environmental damage but, after a certain point, is able to improve environmental quality. Environmental damage can be repaired through technological advances and shifts to a service-based economy (Grossman and Krueger, 1991). While the concept of Pollution Haven Hypothesis is a situation where the company will invest in developing countries that have low tax rates and rules that are not too binding. This causes the longer FDI to bring environmental problems in developing countries (Sbia et al., 2014).

Environmental Kuznet Curve and Pollution Haven hypothesis (PHH) are both seeing the negative impact of FDI on environmental, despite of that concept, Pollution Halo Hypothesis investigate the positive affect of FDI on the environment. FDI investment will reduce environmental pollution in the host country along with increasing productivity, energy efficiency, technology diffusion, and management skills. Meanwhile, Heckscher-Ohlin's theory explains that a country will trade with other countries if the country has differences in tastes marked by differences in the country's economic conditions that trade. The essence of the Heckscher-Ohlin model is that a country tends to export goods that use more abundant relative production factors in the country. In the next chapter the author will discuss deeply regarding the research studies and the findings that is supporting the present research studies.

2.1. The Relationship between FDI and CO_2

There are growing literature investigating the impact of FDI, Tourism and Trade on CO_2 emission in Asia. FDI affects the quality of the environment through different effects, namely, Scale Effect, Composition Effect, and Technical Effect (Grossman and Krueger, 1991). According to Scale Effect, FDI increases pollution by simply improving the economy, Ceteris Paribus (Antweiler et al., 1998). The effect of composition effects stipulates that FDI can increase or reduce pollution by changing the pattern of economic activity (Liobikienė and Butkus, 2019).

Technical Effect prove that foreign companies could bring more environmentally friendly technology, which will also have an impact on domestic companies (Gormus and Aydin, 2020; Zhu et al., 2007). This effect will improve the environment by reducing emissions because resources will be used efficiently, and thus less pollution will be issued. FDI also affects pollution through other effects, called income effects. When income increases due to direct foreign investment, people demand more stringent regulations and high environmental standards. As a result, pollution will decrease. If the Technical Effect dominates, FDI will reduce pollution. However, if scale effects dominate, pollution will increase with FDI (Jun et al., 2018). On the other hand, there are several studies shows different result of the relationship between FDI and CO_2 or environmental degradation. The unsignificant positive impact of FDI on CO_2 are founded the Belt and Road Initiative (BRI), China. (Jijian et al., 2021; Udemba, 2019), while other studies successfully shows the small impact of FDI on Environmental degradation (Seker et al., 2015).

2.2. The Relationship between Tourism and CO_2

A good number of studies already examines the relationship between tourism and CO_2, mostly using panel data analysis namely, EU Countries (Ahmad et al., 2019; Arbulú et al., 2015; Badulescu et al., 2021; Bayar et al., 2021; Bayar et al., 2021; Dritsaki and Dritsaki, 2014; Paramati et al., 2017), Asia (Ahmad

et al., 2019), ASEAN 5 (Azam et al., 2020; Tang and Tan, 2015), Gulf Cooperation Council (Alhowaish, 2016), Mediterranean countries (Dritsaki and Dritsaki, 2014), Muslim Countries (Muhammad et al., 2021), and OECD (Liddle, 2012). While the other research studies focuses on countries level of data for example Italy (Ercolano et al., 2018), Pakistan (Khan et al., 2020; Khan and Ahmad, 2021; Liu et al., 2019), China (Tang et al., 2014; Udemba, 2019), Turkey (Koçak et al., 2020), Cyprus (Katircioglu et al., 2014), Spain (Mateu-Sbert et al., 2013), Switzerland (Jaligot and Chenal, 2018).

The majority of the studies has already proven that the relationship between tourism and CO_2 are positive and statistically significant (Katircioglu et al., 2014; Koçak et al., 2020; Lu et al., 2019; Mikayilov et al., 2019; Tang et al., 2014). The effect of tourism performances on CO_2 emission can be seen from several channel. Most of the research studies using energy uses by international and national tourist to visit tourist destination (Gössling et al., 2015). The tourism development in the long term can be negatively impact on environmental condition by increasing the demand of transportation which majority uses non-renewable energy (Katircioglu et al., 2014). While in China, the supporting sector for tourism namely accommodation, catering and entertainment can accumulate in the long term and increase the total CO_2 in national level (Tang et al., 2014).

Second channel is the environmental and natural resource exploitation to create advanced infrastructures. The advanced infrastructure such as luxury hotel, airport, road and harbour needs to be prepared to attract more tourist to visit the destination (Liu et al., 2022). The tourism development also create waste problems, demand more fresh water and deforestation (Ali et al., 2017; Katircioglu et al., 2014; Wei and Lihua, 2022).

2.3. The Nexus between Trade and CO_2

The impact of Trade and carbon emission has been discussed in decades and the result is quite vary. The main theory are built by (Grossman and Krueger, 1991) the same as tourism sector, the channel is energy use by shipping, fuel and storage. Since the paper published, many empirical research has been done in this such as in France (Mutascu, 2018), Kuwait (Wasti and Zaidi, 2020), Nigeria (Zubair et al., 2020), and China (Zhang et al., 2017) and group of countries namely Africa (Dauda et al., 2021; Opoku-Mensah et al., 2021; Tugcu, 2014), selected countries (Khan et al., 2020; Khan and Ahmad, 2021; Kim et al., 2019; Muhammad et al., 2020), Europe (Du et al., 2020; Kasman and Duman, 2015), newly industrialized countries (Zhang et al., 2017), South Asia (Rahman et al., 2020), Mena Countries (Omri et al., 2015)

The effect of trade on CO_2 emission are non-linear relationship confirm that there is Environmental Kuznet Curve (EKC) (Du et al., 2020; Shahbaz et al., 2017). According to (Du et al., 2020) when income level is lower than 16.883,45 US$, the increasing of international trade also increase the CO_2 emission. This research also supported by (Muhammad et al., 2020) that HPP in the Middle income countries exist. Unfortunately, in another research does not confirm the relationship between trade and CO_2 emission (Zhang et al., 2017). While other research studies confirm there is causality relationship between these 2 variable (Hdom and Fuinhas, 2020; Hussain and Rehman, 2021; Kasman and Duman, 2015; Rahman et al., 2020; Shahbaz et al., 2017; Zubair et al., 2020).

Meanwhile in the high-income countries, the growth of trade flows promotes access for environmentally friendly technology from one country to another (Gormus and Aydin, 2020). The demand of environmental standards and regulation also plays important rules in the high income countries (Kim et al., 2019). International trades allow developing countries accepts the advanced technology which increase the local environmental quality in the end. The impact of trade competition will initiate national company in the developing countries to improve their research and development as well as using green technologies (Thoenig and Verdier, 2003).

3. RESEARCH METHODS

3.1. Data and Samples

The present empirical research wants to examines the impact of FDI, Tourism and trade on CO_2 emission in Asia by using Poisson Pseudo-Maximum Likelihood (PPML) method to estimate data from 2010 to 2019. The authors collect data from high-income, upper-middle-income, and lower-middle-income in Asia so the present research can give a varies result with robust estimates. The level of income that varies each country will show different influence on the quality of the environment, and also Asia has so far been the world's biggest emission producer. This study consists of independent variables (GDP per capita, energy use, direct foreign investment, international tourism receipts, exports, imports) and dependent variables (carbon dioxide/CO_2 emissions). The following is the operational definition as the basis for the variables use as shown by Table 1.

The model used in this study for high-income countries, upper-middle-income, and lower-middle-income in Asia is as follow:

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \varepsilon_{it} \quad \text{Equation 1}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnFDI_{it} + \beta_5 lnFDI_{it}^2 + \varepsilon_{it} \quad \text{Equation 2}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnTOUR_{it} + \beta_5 lnTOUR_{it}^2 + \varepsilon_{it} \quad \text{Equation 3}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnX_{it} + \beta_5 lnX_{it}^2 + \varepsilon_{it} \quad \text{Equation 4}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnM_{it} + \beta_5 lnM_{it}^2 + \varepsilon_{it} \quad \text{Equation 5}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnFDI * lnTOUR_{it} + \varepsilon_{it} \quad \text{Equation 6}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnFDI * lnX_{it} + \varepsilon_{it} \quad \text{Equation 7}$$

$$lnCO_{2it} = \beta_0 + \beta_1 lnGDPPC_{it} + \beta_2 lnGDPPC_{it}^2 + \beta_3 lnEUSE_{it} + \beta_4 lnFDI * lnM_{it} + \varepsilon_{it} \quad \text{Equation 8}$$

Table 2 explains some variables of different state classifications, namely high income, upper-middle income, and lower-middle-income consisting of observation, mean, median, standard deviation, minimum, and maximum.

Table 1: Variable definition

Variables	Definition	Symbol
Carbon dioxide emissions (CO_2)	Carbon dioxide emissions are produced from fuel consumption in the form of solid, liquid, and gas. Data used metric tons per capita and modified into the form of natural logarithms	CO_{2it}
Gross Domestic Product Per capita (GDP per capita)	Gross Domestic Product per capita is obtained from gross domestic product divided by a mid-year population. GDP is calculated from the added value added by all domestic producers in the economy plus taxes and minus subsidies that are not included in the product value	$GDPPC_{it}$/ $GDPPC_{it}^2$
Energy use	The use of energy is measured by the use of primary energy before transformation to other end-user fuel, which is also used for international transportation. The unit of this variable is expressed in the form of kg per capita and is changed to the form of natural logarithms	$EUSE_{it}$
FDI	Foreign direct investment is related to the population in a country that has control of the management of companies in other countries. This variable is stated in the current U.S. dollar (Current US $). Data from this variable divided by the total population to obtain per capita data is then changed into the natural logarithm	FDI_{it}/ FDI_{it}^2
International Tourism Receipts	This variable is an international expenditure, including payment to national operators for international transportation. This variable also includes other payments or payments of goods and services received in the destination country	$TOUR_{it}$/ $TOUR_{it}^2$
Export	Exports are goods and services sent to all countries. Data from this variable is divided by the total population to get per capita data and amended into the form of natural logarithms	X_{it}/ X_{it}^2
Import	Imports are goods and services received from all countries. Data from this variable is divided by the total population to get per capita data and amended into the form of natural logarithms	M_{it}/ M_{it}^2

4. RESULTS AND DISCUSSION

4.1. Testing Environmental Kuznet Curve (EKC) and Pollution Haven Hypothesis

Tables 3-5 shows the regression result based on the state group namely High-income countries, Upper-middle income countries and lower-middle income countries. The results of the study for the High Income and Upper-Middle Income countries in Asia showed that GDP/capita and GDP/capita2 each have a significant positive and negative effect. The present studies confirm that Environmental Kuznet Curve (EKC) exist in both high-income and upper middle-income countries. In the early stages in the high-income country and upper-middle-income GDP per capita increase carbon dioxide emissions, but after reaching a turning point, GDP per capita lowers carbon dioxide emissions. This means that carbon dioxide emissions increase along with per capita income during the early stages of economic growth and then decrease along with per capita income after reaching turning points. It also confirms non-linear relations between GDP and emissions indicated by an inverted u-shaped curve. These findings confirm the EKC hypothesis supported by (Kim et al., 2019; Le et al., 2016; Mazur et al., 2015), which is included in the high-income country category, where the valid EKC hypothesis in the country. Meanwhile, for the country with low-middle income in Asia, GDP/capita and GDP/capita2 each have a negative and positive influence, but both variables are not significant. This proves that the EKC hypothesis is invalid in Lower-Middle Income in Asia. This finding is in line with the research conducted by the (Chang et al., 2018; Jensen, 2021; Muhammad et al., 2020; Taguchi, 2013) in the lower income countries.

The largest GDP per capita impact occurs at the upper-middle-income level, while the smallest impact occurs at the high-income

Table 2: Statistical Description

Variable	Obs	Mean	Std. Dev.	Min	Max
High Income					
CO_2	91	16.57086	9.97744	2.203863	43.52329
GDPPC	130	37535.05	14926.72	14992.61	71992.15
EUSE	63	6931.281	3866.326	1943.845	17922.73
FDI	125	2962.347	5179.371	-993.1394	24830.61
TOUR	114	6197.266	16099.69	98.04198	75627.15
X	124	33587.02	29443.21	6688.422	121950.1
M	124	25377.06	26252.96	5359.46	103583.4
Upper-Middle Income					
CO_2	91	5.954016	3.806042	1.450032	15.6463
GDPPC	127	7003.501	2919.53	3122.363	15068.98
EUSE	61	2149.295	1286.917	833.562	4893.41
FDI	123	272.8694	271.8808	-295.7228	1113.104
TOUR	107	865.8332	1492.254	27.81242	6461.846
X	91	2946.96	2128.545	758.7039	8554.221
M	91	3068.306	1795.096	535.3714	7591.791
Lower-Middle Income					
CO_2	35	2.095642	0.8514771	0.7114644	3.889733
GDPPC	49	2033.017	691.6021	880.0378	3128.001
EUSE	19	878.7269	374.5216	505.4023	1625.988
FDI	49	46.95782	38.7967	-22.20288	192.0553
TOUR	40	79.49401	56.14033	4.236339	205.2127
X	48	552.6418	209.9971	304.1069	1001.914
M	48	817.0009	434.3041	322.6642	1745.641

Source: Stata 14.2, Data is processed

Table 3: High income country estimation results

Dependent: $lnCO_2$	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
lnGDPPC	1.963969***	1.746744***	1.369116**	1.04058**	1.744833***	1.885924***	1.880118***	1.87391***
	(0.001)	(0.001)	(0.041)	(0.032)	(0.001)	(0.003)	(0.001)	(0.001)
$lnGDPPC^2$	−0.095776***	−0.0843529***	−0.665415**	−0.0502869**	−0.084187***	−0.0915905***	−0.0911629***	−0.090854***
	(0.001)	(0.001)	(0.040)	(0.032)	(0.001)	(0.003)	(0.001)	(0.001)
lnEUSE	0.3649299***	0.3511839***	0.3583484***	0.3354782***	0.351075***	0.3596293***	0.3633619***	0.36149***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnFDI		0.0244376***						
		(0.000)						
$lnFDI^2$		−0.00247***						
		(0.000)						
lnTOUR			0.0118632***					
			(0.007)					
$lnTOUR^2$			−0.0018457***					
			(0.002)					
lnX				0.0228372*				
				(0.083)				
lnX^2				−1.42***				
				(0.000)				
lnM					0.147775			
					(0.522)			
lnM^2					−0.008606			
					(0.453)			
lnFDI*lnTOUR						−0.0007487**		
						(0.023)		
lnFDI*lnX							−0.0005363**	
							(0.043)	
lnFDI*lnM								−0.000594**
								(0.027)
R-squared	0.957	0.963	0.962	0.967	0.964	0.957	0.959	0.959

***, **, and *significant at 1% level, 5% and 10%, Source: Data processed using STATA 14.2

level. That is, CO_2 emissions per GDP unit in high income are lower than Upper-Middle Income. This is in line with the fact that developed countries have several advantages in terms of energy efficiency, economic structure, energy use structure, and energy technology. The impact of carbon dioxide emissions in lower-income countries due to a shift in the transformation from the agricultural sector to the industrial sector (Sarkodie and Strezov, 2018). At low-income levels, pollution reduction is difficult because more individuals use their income to meet their basic consumption needs (Katsoulakos et al., 2016).

Energy use has a positive and significant relationship in the country of High Income, Upper-Middle Income, and lower-middle-income. This proves energy consumption in high-income countries increases carbon dioxide emissions even though it has used new and renewable energy (EBT) (Gormus and Aydin, 2020). In comparison, the use of energy in the Upper-Middle Income and lower-middle-income countries increases carbon dioxide emissions because the country tends to consume more energy. This is due to the transition to become a high-income country (Jalil and Yazan, 2018).

FDI at the initial stage has a positive and significant effect on the country of High Income, Upper-Middle Income, and Lower-middle-income. The influence of FDI in high-income countries is caused by technological advancements and economic structures. According to Sarkodie and Strezov, (2018), the Technique Effect has a large impact on the high-income country compared to the Composition Effect and Scale Effect. This effect improves the environment by reducing emissions because resources are used efficiently, and thus fewer pollution is incurred.

In the Upper-Middle Income Country, FDI causes an increase in pollution in the short term and lowers it in the long run. Short-term effects support Haven Hypothesis pollution (PHH). However, in the long run, FDI reduces emissions. It supports Halo Hypothesis pollution. That is, the upper-middle-income country can receive direct and clean direct foreign investment. In the short term, FDI does not improve the environment because the low capabilities of the state upper-middle-income absorb technology. However, in the long run, this country combines new technology and techniques, applying knowledge to domestic companies so that it can reduce emissions (Marques and Caetano, 2020). This finding is supported by Balsalobre-Lorente et al., (2019) in the country of Indonesia. Increased environmental degradation at the initial stage due to the development of high-tech industrial procedures through FDI. Over time, FDI contributes to reducing environmental damage in the country of Indonesia.

FDI in the country of lower-middle-income affects carbon dioxide emissions through economic growth or scale effects. This is because FDI can increase economic activity in the lower-middle-income country so that FDI has contributed to encouraging economic growth but has an impact on increasing carbon dioxide emissions. This is in line with Tang and Tan (2015) research which shows that in Vietnam, FDI influences the environment and reduces

Table 4: Upper-middle income country estimation results

Dependent: $lnCO_2$	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
lnGDPPC	7.492193***	7.660858***	7.647047***	4.594252**	5.466341***	6.855393***	5.422894***	5.367916***
	(0.001)	(0.001)	(0.001)	(0.011)	(0.007)	(0.004)	(0.009)	(0.009)
$lnGDPPC^2$	−0.415317***	−0.4255074***	−0.4242332***	−0.2524613**	−0.3011574***	−0.381216***	−0.2988286***	−0.2960489***
	(0.001)	(0.001)	(0.001)	(0.013)	(0.008)	(0.004)	(0.010)	(0.010)
lnEUSE	0.5251962***	0.5504031***	0.528644***	0.5795294***	0.5784536***	0.5710544***	0.5642667***	0.5681184***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnFDI		0.3105129*						
		(0.087)						
$lnFDI^2$		−0.0294488*						
		(0.091)						
lnTOUR			0.0360662**					
			(0.011)					
$lnTOUR^2$			−0.0048741**					
			(0.036)					
lnX				1.313141*				
				(0.061)				
lnX^2				−0.082688*				
				(0.054)				
lnM					0.8122811*			
					(0.062)			
lnM^2					−0.0518096**			
					(0.055)			
lnFDI* lnTOUR						0.0002036		
						(0.907)		
lnFDI*lnX							0.0015574	
							(0.158)	
lnFDI*lnM								0.0019577*
								(0.088)
R-squared	0.925	0.930	0.932	0.943	0.943	0.920	0.944	0.944

***, **, and *significant at 1% level, 5% and 10%, Source: Data processed using STATA 14.2

Table 5: Lower-middle income countries estimation results

Dependent: $lnCO_2$	Model 17	Model 18	Model 19	Model 20	Model 21	Model 22	Model 23	Model 24
lnGDPPC	−4.239511	−4.517322	40.75122***	−7.407051	27.74167***	11.52659	−4.135894	−1.360528
	(0.317)	(0.275)	(0.000)	(0.106)	(0.002)	(0.407)	(0.442)	(0.853)
$lnGDPPC^2$	0.3156962	0.3304617	−2.763938***	0.5389715*	−1.843611***	−0.7575546	0.3086776	0.1219543
	(0.270)	(0.229)	(0.000)	(0.081)	(0.003)	(0.420)	(0.387)	(0.803)
lnEUSE	1.090305***	1.094396***	2.351286***	1.097027***	1.072.918***	1.251725***	1.089534***	1.076855
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnFDI		1.233444**						
		(0.048)						
$lnFDI^2$		−0.1666388*						
		(0.057)						
lnTOUR			1.73285***					
			(0.000)					
$lnTOUR^2$			−0.1987079***					
			(0.000)					
lnX				22.32504***				
				(0.005)				
lnX^2				−1.862772***				
				(0.004)				
lnM					−12.52536***			
					(0.000)			
lnM^2					1.050944***			
					(0.000)			
lnFDI*lnTOUR						0.0254874		
						(0.190)		
lnFDI*lnX							0.0002621	
							(0.971)	
lnFDI*lnM								0.0065085
								(0.485)
R-squared	0.966	0.970	0.981	0.969	0.982	0.939	0.965	0.966

***, **, and *significant at 1% level, 5% and 10%, Source: Data processed using STATA 14.2

pollution by transferring technology and environmentally friendly production techniques from developed countries.

Influential tourism increases carbon dioxide emissions in the country of High Income, Upper-Middle Income, and lower-middle-income in Asia, but after reaching a certain point, tourism will have a good impact on the environment. This is evidenced by the quadratic tourism variable. These results validate non-linear relationships with a U-reverse curve between tourism and carbon dioxide emissions. This finding is in line with Ghosh, (2020), which also proves that emissions caused by tourism continue to increase, but after reaching a certain point, the impact of tourism on carbon dioxide emissions will decrease significantly.

Exports have a significant positive effect on the country of High Income, Upper-Middle Income, and Lower-Middle Income in Asia. This means that exports increase carbon dioxide emissions in each state classification. This is due to inefficient use of energy and natural resources for production activities, resulting in an impact on increasing carbon dioxide emissions in these countries. Export and carbon dioxide emissions also have non-linear relationships. This shows the existence of a U-reverse curve between exports and carbon dioxide emissions. This is evidenced by the Export of squares that have a negative and significant influence on carbon dioxide emissions. The decline was due to the emission reduction policy. In addition, the change of technology from pollutant technology to environmentally friendly technology also helps reduce carbon dioxide emissions. This finding is in line with (Chang et al., 2018), which shows that the increase in exports has an impact on the decline in carbon dioxide emissions in 65 industrial and developing countries. In developed countries, when manufacturing export increases, the level of carbon dioxide emissions decreases. This happens because exported goods in production such as manufacturing tend to be environmentally friendly. This is due to the use of modern technology that is environmentally friendly by developed countries.

Import has a different effect on every state classification. The results show that in high-income countries, imports have no effect on carbon dioxide emissions. The upper-middle-income country has a non-linear relationship with a U-reverse curve. At the same time, the curve in the Country of Lower-Middle Income in the form of U. Import has no influence on carbon dioxide emissions in the high-income country. This is because the high-income state can meet domestic needs, so that it tends to be more exporting than importing goods and services from other countries. The non-linear relationship between imports and carbon dioxide emissions in the upper-middle-income state shows that over time, imports can reduce carbon dioxide emissions. This is because trading facilitates environmentally friendly technology transfers. The findings in the lower-middle-income state indicate that more and more low-middle income countries import goods and services from other countries, especially from high-income countries, the higher the level of carbon dioxide emissions. This is because the Lower-Middle Income State is still dependent on other countries to meet domestic needs.

In high-income countries, variable interactions between FDI and tourism have a negative and significant influence on carbon dioxide emissions. In contrast, the upper-middle-income and lower-income countries have no effect on carbon dioxide emissions. Variable interactions between FDI and exports have a negative influence on carbon dioxide emissions in a high-income country. In comparison, the upper-middle-income and lower-middle-income countries have no effect on carbon dioxide emissions. Variable interactions between FDI and imports in high-income countries have a negative and significant influence on carbon dioxide emissions. In the Upper-Middle Income Country, the interaction of FDI and imports variables has a positive and significant influence. Whereas in the lower-middle-income state, variable interactions between direct foreign investment and imports have no effect on carbon dioxide emissions.

5. CONCLUSION AND SUGGESTION

Valid EKC hypothesis in the country of High Income and Upper-Middle Income in Asia, while the EKC hypothesis is invalid in the country of lower-middle-income in Asia. The use of energy has a positive and significant effect on the GNI-based state group, namely the High Income, Upper-Middle Income, and lower-middle-income. Foreign direct investment has non-linear and significant relationships with carbon dioxide emissions in the state group based on GNI, namely High Income, Upper-Middle Income, and Lower-Middle Income in Asia. Tourism has non-linear and significant relations with carbon dioxide emissions in the state group based on GNI, namely High Income, Upper-Middle Income, and Lower-Middle Income in Asia. Exports have non-linear and significant relationships with carbon dioxide emissions in the state group based on GNI, namely High Income, Upper-Middle Income, and Lower-Middle Income in Asia in 2010-2019. Imports have non-linear and significant relationships in the upper-middle-income and lower-middle-income countries but are not significant in high-income countries in Asia.

Limitations in this study are the limited data used, so they do not include low-income state classifications in Asia, which should be included in the classification of countries based on GNI according to the World Bank. Therefore, it's expected for further research in order to increase or use several other variables related to carbon dioxide emissions (CO_2).

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