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Carbon Emissions In Indonesia Viewed From Tourism Aspect

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ABSTRACT

The purpose of this study is to see the effects of the tourism sector on the number of carbon emissions in Indonesia. The importance of the tourist industry in Indonesia is growing in parallel with its growth and economic contribution, but It is undeniable that all economic activity, including tourism, has an impact on environmental change, particularly the rise in carbon dioxide emissions. Therefore, testing was carried out using the Autoregressive Distributed Lag (ARDL) method to see the long-term and short-term relationships between the independent variables to the dependent variable. The variables used in this study are CO_2 emission values, tourist arrivals, tourism contribution to GDP and foreign direct investment. For long-term analysis, FDI has no effect on carbon emissions in Indonesia, tourist arrivals have a positive and significant effect on alpha 1%, while the contribution of tourism to GDP has a negative and significant effect on alpha 5% on carbon emissions. In the short-term the CO_2 variable from the previous period has a significant positive effect on current CO_2, current tourist arrivals have a significant negative effect on current CO_2 (10% error rate) and the Tourism Contribution of the previous two periods has a significant negative effect on the 5% error rate to the number of carbon emissions in Indonesia.

Keyword: Carbon Emissions, Tourism, Foreign Direct Investment

1. Introduction

Due to its enormous potential, the tourism industry in Southeast Asia is expected to play a significant role in the region's robust economic growth. There is a close interaction between tourism and other businesses, such as lodging, transportation, information technology, and so on. These sectors not only require a lot of capital, but also employ a big number of people. So with the advancement of tourism in this region it is predicted that it will result in an extraordinary multiplier effect in increasing the welfare of citizens. Thus the indicators of tourism development in this region are very clear, which are related to the development of the number of tourism destinations followed by their variations and dynamics, the increasing number of supporting facilities (airports, cruise ports, hotels, In Indonesia, the role of the tourism sector is increasingly important in line with the development and contribution it makes through regional income, foreign exchange earnings, regional development, the absorption of investment and manpower as well as business development which are spread across various regions in Indonesia10.23 million foreign visitors traveled to Indonesia in 2015. According to The World Travel & Tourism Council (WTTC), the country's tourism industry experienced the greatest growth in 2018 and was ranked 9th in the world, 3rd in Asia, and first in Southeast Asia. And in 2019 the number of foreign tourists coming increased to 16.11 million. In addition, based on The Travel & Tourism Competitiveness Report, at the World Economic Forum the ranking of Indonesia's tourism competitiveness index in the world rose from 42 in 2017 to 40 in 2019 out of 140 countries. These figures illustrate how quickly Indonesia's tourism industry is growing.

The tourism business has long been recognized as a smokeless industry. As a sector, tourism generates revenue and advantages for society, culture, and economy without establishing industries that release smoke or otherwise endanger the environment (Santoso, 2016). However, this statement is being debated in various

circles. This is because travelers utilize a variety of transportation options that produce emissions and carbon, which can harm the environment. In addition, traffic jams caused by tourism activities emit emissions and carbon.

As with other economic activities, the tourism sector also has an impact on the environment, one of which is highlighted is the increase in carbon emissions. The main source of carbon dioxide (CO_2) is burning fossil fuels, and one of the contributors is transportation activities. According to assessments from Google, Temasek, and Bain & Company, Southeast Asia is one of the regions most vulnerable to climate change risks and consequences with Jakarta playing an important part as a contributing city at 40 %. It is projected that with all kinds of economic activities the number of carbon emissions will reach 20 Metric tons of carbon dioxide equivalent (MTCO2e) in 2030.

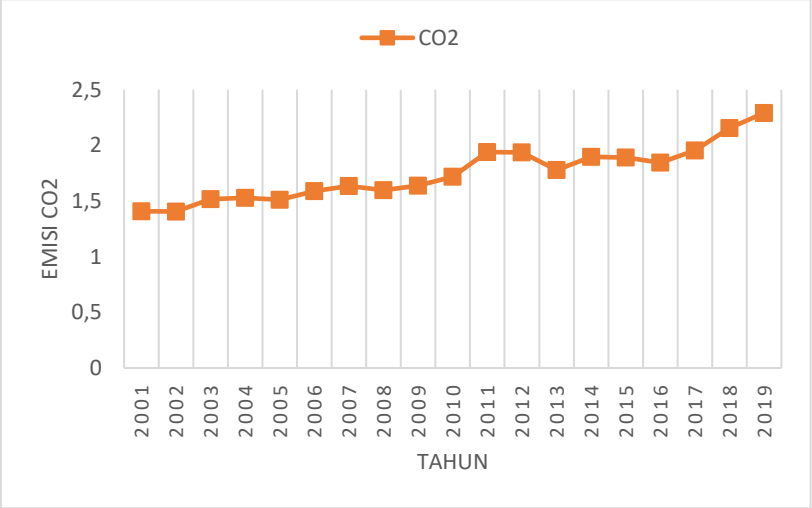

Figure 1. Graph of Increasing CO2 Emissions in Indonesia

The tourist sector's contribution and participation in the global market undoubtedly has an impact on a country's economic development. Environmental challenges are too complex to ignore. Policy approaches, particularly in the tourism sector, need to promote sustainable development while taking into account environmental challenges including climate change and carbon emissions from the tourism industry. The importance of the tourism economy raises questions for policymakers about how the tourism sector can encourage economic growth while reducing carbon emissions. For long-term analysis, FDI has no effect on carbon emissions in Indonesia, tourist arrivals have a positive and significant effect on alpha 1% on carbon emissions.

2. Literature Review

In the literature review, a summary and description are provided of the literature that is related to the current study project. In addition to the impact of the tourism sector on Indonesian carbon emissions, the research variable includes foreign investment.

2.1 Tourism and Carbon Emissions

Sustainability is a vital necessity for countries looking to grow their tourism industries. As planners, the government is responsible for making sure that the development of tourism products is in harmony with the surrounding environment. Effective planning and precise instructions about the scope and depth of the development process are necessary for the development of sustainability. To attain this goal, those working in the tourism industry can receive intense training and mentoring, and efforts to address the relationship between tourism and the environment can be sponsored by governments and organizations (McDonagh & Prothero, 2014).

Tourism activities are directly involved with transportation and are highly dependent on various infrastructure services such as airports, ports, roads, rail and telecommunications. Developments carried out to support tourism development such as infrastructure, resorts and restaurants certainly have an impact on the environment and ecology. The effects of global environmental change show dramatic changes, especially in climate change, these changes have a sizeable impact on various natural tourist destinations, such as mountainous, coastal and lake areas (Gössling & Hall, 2006). In addition, nowadays tourists prefer to use

private vehicles to explore, and this encourages more severe environmental damage (Black, 2007).

Tourist trips almost always depend on fossil fuels which are used as modes of transportation to transport tourists to and from tourist destinations and within tourist destinations, at accommodations and to carry out various tourist activities. Fossil fuels are linked to greenhouse gas emissions. There are several significant studies on the issue of energy consumption related to the tourism sector, especially its implications for environmental issues such as its contribution to greenhouse gases and global warming (Bode, Hapke, & Zisler, 2003) (Gössling, Peeters, & Scott, 2008). A study commissioned by the United Nations World Tourism Organization (UNWTO , 2008) estimates the global tourism linkage – CO_2 emissions to be approximately 5 percent of total global emissions. Most of these emissions are generated by tourist transportation, especially air travel. This shows that the contribution of the tourism sector to climate change is very large and is at the global level.

2.2 FDI and Carbon Emissions

Investments that support more access to financial capital, which businesses can use to expand company operations or by building new factories, all of which increase energy demand. FDI leads to better economic growth but also has the potential to increase CO_2 emissions. Investments in the tourism sector such as the construction of hotels, restaurants and amusement parks which are made to meet the needs of tourists will produce residues in the form of waste that uses a lot of energy for its operating system (Romeril, 1985).

Tamazian et al., (2009) argue that FDI helps companies promote technological innovation and adopt new technologies and, thereby, increase energy efficiency and advance low-carbon economic growth in potential superpowers Brazil, Russia, India and China, also known as BRIC countries. List & Co, (2000) find that inflows of FDI help promote host country energy efficiency and cut CO_2 emissions.

On the other hand, FDI from private investors provides more access to financial capital, which can be used for business expansion and expanding their operations by building new factories, all of which can increase energy demand. FDI that leads to greater economic growth has the potential to have a significant impact on energy demand and increased CO2 emissions. This relationship should be considered when developing energy policies and carbon emission strategies, especially when governments attract FDI to accelerate their economic growth. Several studies confirm the above statement, Within a sample of twenty developing nations, Mielnik & Goldemberg (2002) discovered a correlation between foreign direct investment and energy use.

To analyze the effect of tourism on carbon emissions, this study uses the Autoregressive Distributed Lag (ARDL) regression method. This method is used to look at the long-term and short-term relationships between the influence of tourism variables on carbon emissions in Indonesia. The variables used in this study are CO2 emissions, tourist arrivals (TA), tourism receipts (TR) and foreign direct investment (FDI). Therefore, the hypothesis developed in this study is:

1. H_1 = There is no long-term relationship between tourist arrivals, tourism receipts and foreign direct investment on carbon emissions in Indonesia.
2. H_2 = There is no short-term relationship between tourist arrivals, tourism receipts and foreign direct investment in carbon emissions in Indonesia.

3. Research Method

3.1 Data

This study takes use of secondary data from the World Bank (World Bank, 2022) and Refinitif (Refinitif, 2024), with sampling limited to the years for which data are available, specifically 2002 through 2019. Additionally, the interpolation method created by (Insukindro & Karseno, 1985) transformed yearly data into semi-annual (2002:1 to 2019:2) in order to offer sufficient time series data and data normalization, and to change values in comparable units of measurement, a logarithmic transformation was performed on tourist arrival data. Variables and their definitions are as follows:

Table 1.Research Variables and Definitions

Variable	Definition
Dependent variable	
Carbon emissions (CO_2)	CO_2 is produced due to the consumption of solid, liquid and gas fuels. (Metric Ton per capita)
Independent Variable	
Tourism Contribution (TR)	Percentage of tourism's direct contribution to GDP
The arrival of tourists (TA)	Number of tourists coming to Indonesia (million people)
Foreign Direct Investment (FDI)	Percentage of FDI inflows to GDP

3.2 Method of Analysis

The regression model used in this study is Autoregressive Distributed Lag (ARDL). This model assumes that a variable will be influenced by the variable itself in the previous period (Ekananda, 2016). In using the ARDL method several testing steps are required, namely 1) Unit Root Test. Although the variables in the model may not be stationary at the same degree, Pesaran and Shin (1998) suggest avoiding stationary variables at the second degree. Therefore, as a preliminary test for ARDL, a unit root test using Augmented Dickey-Fuller (ADF Test) was performed to justify the stationary order of the variables. 2) Determination of the maximum lag. The determination of the maximum lag is used by the cointegration test with the Akaike Information Criteria (AIC) model, where the determination is based on the smallest AIC value.

$$\Delta CO2_t = \beta 0 + \beta 1 CO2_{t-1} + \beta 2 FDI_{t-1} + \beta 3 Log(TA)_{t-1} + \beta 4 TR_{t-1} + + \sum_{i=0}^{q} \delta_{2i} \Delta FDI_{t-i} + \sum_{k=0}^{q} \delta_{3k} \Delta Log(TA)_{t-k} + \sum_{m=0}^{q} \delta_{4i} \Delta TR_{t-m} + \varepsilon t \quad (1)$$

Where CO2 is carbon emissions, FDI is foreign direct investment, TA is the number of tourist arrivals and TR is tourism contribution.

The next step 5) To estimate the long-run coefficients, when cointegration occurs in the long run, the next step is to estimate the long-run equation. The ARDL model can be formulated as follows:

$$CO2_t = \alpha + \beta 1 FDI_t + \beta 2 Log(TA)_t + \beta TR_t + \mu t \quad (2)$$

6) Then estimate the short-term coefficient. After obtaining the Error Correction Term in the long-term coefficient test, the short-term model can be determined as follows

$$\Delta CO2_t = \alpha + \varepsilon t(3) \sum_{i=1}^{P} \delta_{1i} \Delta CO2_{t-i} + \sum_{j=1}^{p} \theta_{1j} \Delta FDI_{t-j} + \sum_{j=1}^{p} \theta_{2j} \Delta Log(TA)_{t-j} + \sum_{j=1}^{p} \theta_{3j} \Delta TR_{t-j} + \gamma\, ECT_{t-1} + \varepsilon t \quad (3)$$

And finally, 7) Model stability test, used to avoid errors in concluding. model stability using the CUSUM and CUSUM Square plots (the model is stable from the possibility of one or more structural breaks if the plot does not cross the threshold at 5% significance (Brown, Durbin, & Evans, 1975).

4. Result

4.1 Unit Root Test

To carry out ARDL analysis, as a condition, the stationary variables have been checked and the results are as follows for checking that there are no variables that are stationary in the second difference:

Table 2. Stationarity Test Results

Series	Level		First difference	
	t-statistics	Probability	t-statistics	Probability
CO2	-0.124297	0.9385	-4.169969	0.0026
FDI	-3.395336	0.0192		
TA	-0.399506	0.8982	-3.144362	0.0329
TR	-1.914669	0.3220	-4.220458	0.0022

From the unit root test above, it can be seen that all variables are stationary at the first level of differentiation, except for the FDI variable which is stationary at that level, the difference in the stationary level between these variables is a requirement for performing Auto Regressive Distributed Lag (ARDL) analysis.

4.2 Results of Akaike Information Criteria

Following are the results of the AIC test to determine the maximum lag of ARDL, namely (2,0,1,1) for each of the four variables:

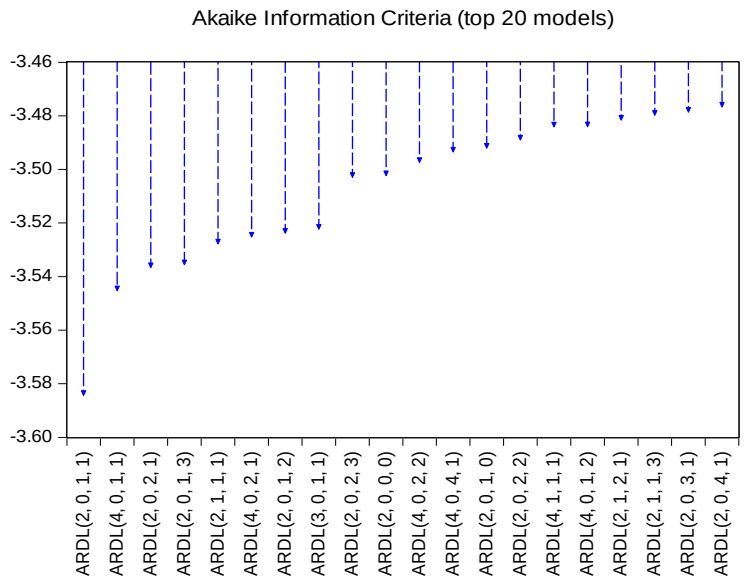

Figure 2. Results of Akaike Information Criteria

4.3 ARDL Cointegration Test Results

The following is the result of cointegration to see the long-term relationship between foreign direct investment, tourist arrivals and tourism's contribution to carbon emissions in Indonesia:

Table 3. Regression Results in Error correction

Variable	Coefficient
ΔCO2(-1)	0,648703***
ΔLog(TA)	-0.275409
ΔTR	0.003128
ΔTR(-1)	0.010442
ΔTR(-2)	- 0,046034**
CointEq$(-1)^*$	-0,496197***
R^2	0.664134
No Of Obs	33
Adj R^2	0.601940

*** , ** , and * indicated the statistical significance of 1.5 and 10 percent, respectively.

To see whether there is a long-term and short-term relationship, you can see the Cointegration Bound Test with the following results:

Table 4. Bound Test Results

Test Statistics	Value	Significant	i(0)	I(1)
F-Statistics	5.581327	10%	2.37	3,2
		5%	2.79	3.67
		2.5%	3,15	4.08
		1%	3.65	4.66

The results of the Bounds Test above show that the F-Statistic value (5.58132) is greater than I(0) and I(1) so it can be said that there is a long-term and short-term relationship between the independent variable and the dependent variable.

4.4 Long-Term and Short-Term ARDL Outcomes

The following are the results of the estimation of the effect of the independent variables on the dependent variable which can be seen from the results of the ARDL Long-Term Form Test:

Table 5. Long-Term Coefficients calculated using the ARDL Approach

Variable	Coefficient	t-statistics
FDI	0.008665	0.371991
Logs(TA)	0,660959***	8.328382
TR	−0,036408**	-2.241873
C	−8,479374***	-7.191293

*** , ** and * denote statistical significance of 1.5 and 10 percent, respectively.

For long-term analysis, FDI has no effect on carbon emissions in Indonesia, tourist arrivals have a positive and significant effect at a 1% degree of error on carbon emissions, this is in line with research conducted by Scott et.al (2010) regarding the relationship between activity tourism which has the potential to increase carbon emissions, they reported that the tourism sector could become a major source of global greenhouse gases in the future. Meanwhile, the estimation results show that tourism's contribution to GDP has a negative and significant effect on alpha 5% of carbon emissions. This confirms that an increase in the contribution of tourism to GDP does not always affect the increase in CO2 emissions in Indonesia, this is supported by research conducted by Lee & Brahmasrene, (2013). This is feasible because Indonesian tourism is progressively implementing sustainable development concepts, which include modifying laws and taking further measures toward encouraging a low-carbon economy. A low-carbon economy has the potential to transform the region into an eco-friendly tourist destination. Indonesia's commitment to reducing greenhouse gases is outlined in the Nationally Determined Contribution (NDC) document. This document is a follow-up to the Paris Agreement which was ratified through Law Number 16 of 2016. In the NDC, it is stated that Indonesia has a national emission reduction target of 29% by 2030.

ARDL Long Term Test also provides the following short-term relationship estimation results:

Table 6. Short-Term Estimation Using the ARDL Approach

Variable	Coefficient	t-statistics
ΔCO2(-1)	0,648703***	5.985696
ΔLog(TA)	-0.275409	-1.736554
ΔTR	0.003128*	0.236225
ΔTR(-1)	0.010442	0.582425
ΔTR(-2)	- 0,046034**	-2.396701
ECT(-1)	-0,496197***	-5.723632
R^2	0.664134	

*** , ** and * denote statistical significance of 1.5 and 10 percent, respectively.

The short-term dynamics of tourism variables can be properly examined. ECT is negative and significant at α = 1%, which means that cointegration occurs in the long term (Murjani, 2019) with an adjustment speed of 49.6% to long-term equilibrium. In the short term it can be seen that the CO2 of the previous period has a significant positive effect on the current CO2, and the arrival of tourists at this time has a significant negative

effect on the current CO2 (10% degree of error) and the tourism contribution of the two previous periods has a significant negative effect on the error rate. 5% of total carbon emissions in Indonesia.

4.5 Model Stability Test

In this ARDL model, CUSUM and CUSUMQ are used to test the stability of the model. Following are the results of CUSUM:

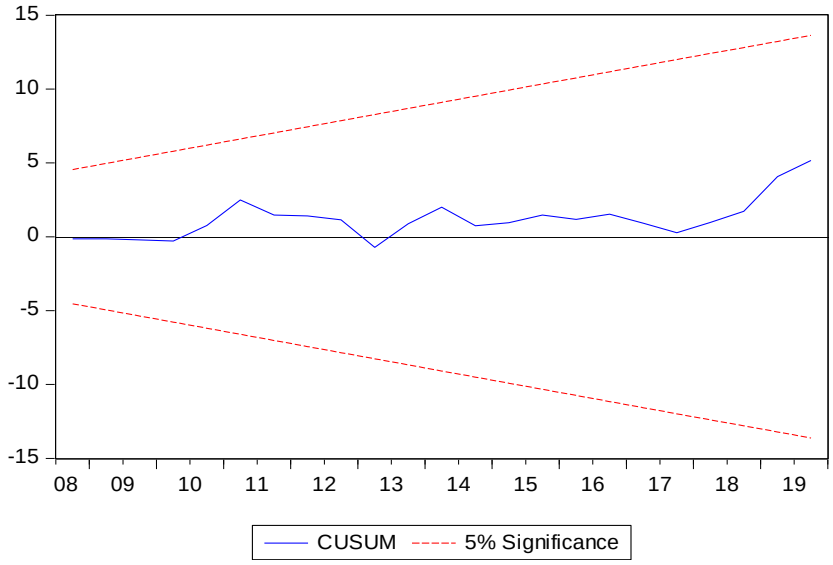

Figure 5. CUSUM Plot

During the observation period, it can be seen that the ARDL model tested has been stable and the coefficients statistically can explain the interaction between the dependent variable and the regressor. This is evidenced by the CUSUM graph above, as well as the CUSUMQ figure where the CUSUMQ plot still enters the critical interval below 5%.

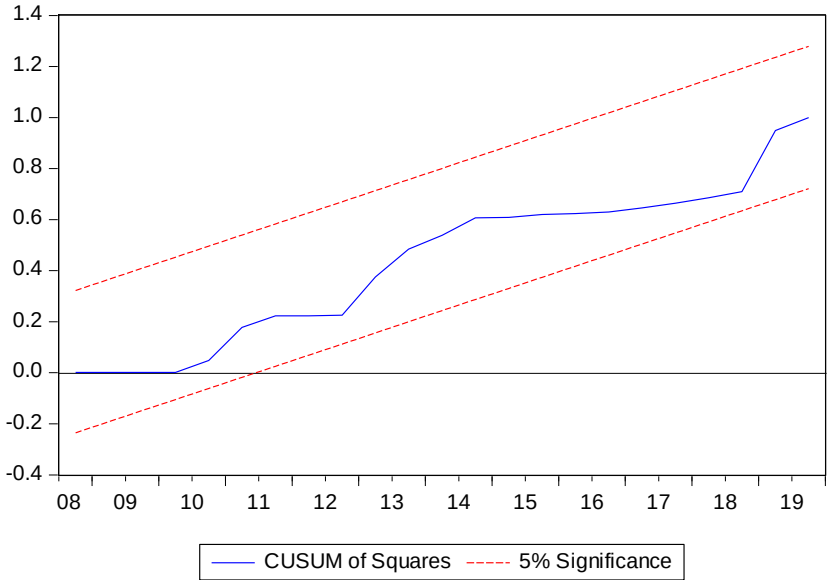

Figure 6. CUSUMQ Plot

5. Conclusion

The impact of the tourism industry on global carbon emissions has been the subject of conflicting research in the past. Various methods used as well as various observation times have been the subject of the cause of the phenomenon. This study aims to investigate that particularly in Indonesia by using ARDL model to suggest

robust conclusions that include time-referenced issues, in the short and long term. Finally, this study formulates several conclusions.

For the long-run analysis, fdi has no effect on carbon emissions in Indonesia, and tourist arrivals have a positive and significant effect at 1% alpha on carbon emissions while from the estimation results it is found that tourism contribution to GDP has a negative and significant effect at 5% alpha on carbon emissions. This confirms that an increase in the contribution of tourism to GDP does not always affect the increase in CO_2 emissions in Indonesia. In the short-term time span, the variable CO_2 one period earlier has a positive significant effect on current CO_2, current tourist arrival has a negative significant effect on current CO_2 (10% error rate) and Tourism Contribution two periods earlier has a negative significant effect at 5% error rate on total carbon emissions in Indonesia. This study provides empirical evidence showing that there is a significant negative relationship between tourism variables and carbon emissions. This findings are in line with many researchers (Gössling, Peeters, & Scott, 2008; Lee & Brahmasrene, 2013; Solarin, 2014; De Vita et al., 2015; Al-Mulali et al., 2015; Ozturk et al., 2016; Akadiri et al., 2019; Ren et al., 2019; Eyuboglu & Uzar, 2020).

6. Recommendations

In order to support the long-term benefits of tourism for locals and visitors without harming the environment, it is important to bring together stakeholders, policy makers, planners, private investors, NGOs, and communities themselves to discuss environmental issues and develop policy and management strategies. Tourism may contribute to environmental degradation, but it also has the potential to achieve considerable environmental improvements by strategically incorporating sustainability into management and development processes. . A restructuring of tourism management governance mechanisms is needed to make this happen.

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