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Investigate the Different Impacts of Tourism on the Economy and Carbon Emissions of High Income and Middle-Income Countries in Asia

Monika Andrasari[1], Sirojuzilam[2], Ahmad Albar Tanjung[3], M.Syafii[4]

Abstract

This study investigates the dual impact of tourism on both economic growth and environmental sustainability in high- and middle-income Asian countries. Employing the Seemingly Unrelated Regression (SUR) method, the research analyzes panel data to assess tourism's influence on Gross Domestic Product (GDP) and carbon dioxide (CO2) emissions. The findings reveal that tourism significantly enhances economic growth in high-income countries, whereas its effect on middle-income countries is comparatively modest. Additionally, tourism is found to substantially increase carbon emissions in high-income nations, with a less pronounced impact in middle-income counterparts. These results emphasize the urgent need for developing and implementing holistic, sustainable tourism policies that address both economic and environmental outcomes. While the study offers valuable insights, its scope is limited to Asian countries, which may restrict broader applicability. The originality of this research lies in its integrative approach, advocating for policies that ensure tourism-driven economic growth is both inclusive and environmentally sustainable.

Keywords: *Tourism, Economy, Carbon Emissions, Asia, Seemingly Unrelated Regression (SUR).*

Introduction

International tourism has become one of the main sectors in the global economy, acting as a significant contributor to global GDP and a provider of employment. According to the World Travel and Tourism Council (WTTC), this sector contributed 10.4% to global GDP in 2019, with over 330 million people employed in the industry (Lew, 2011). Globalization, which drives economic and technological integration, has accelerated the development of this sector, particularly through increased global mobility and accessibility to tourist destinations (Sirojuzilam, 2005).

Previous research shows that tourism plays a crucial role in supporting economic growth through increased foreign exchange, job creation, and investment in infrastructure (Brida et al., 2016; Isik et al., 2018; Balsalobre-Lorente et al., 2020). In Europe, effective policy promotion has contributed to sustainable tourism development, which is a key driver in increasing employment and reducing poverty (Paramati et al., 2018). Ferrer-Roca et al. (2020) highlighted that investment in technology and effective governance is key to supporting sustainable tourism growth. However, the economic impact of tourism varies between high-income and middle-income countries, with high-income countries such as Japan and South Korea showing better economic stability compared to middle-income countries like Indonesia and Vietnam, where infrastructure challenges remain a major barrier.

Furthermore, tourism also has a significant impact on carbon dioxide (CO2) emissions, which is a major concern in the context of global climate change. Asia, with its rapid growth in international tourism, faces significant challenges in balancing economic growth with environmental sustainability. Ritchie et al. (2019) reported that Asia is responsible for 53% of global carbon emissions, and the tourism sector contributes about 8% of global greenhouse gas emissions (Lenzen et al., 2018). Research conducted in China found a negative correlation between tourism development and carbon emissions, indicating that tourism growth can contribute to reducing carbon emissions (Liu & Meng, 2019). However, while tourism can support economic growth, there is a risk of increased carbon emissions that must be managed properly. Šatrović

[1] (ORCID: 0000-0001-8421-7829), University Sumatera Utara. Jl.Prof TM Hanafiah SH, Medan 20155. E-mail: andramonika@usu.ac.id (Corresponding author)
[2] (ORCID: 0009-0005-1425-1539), University Sumatera Utara
[3] (ORCID: 0000-0001-8185-7484), University Sumatera Utara.
[4] 0000-0003-4730-7213, University Sumatera Utara.

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and Muslija (2019) showed that CO2 emissions increase as a result of tourism development and income, particularly through significant contributions from the tourism transportation sector (Yang et al., 2014).

In addition to environmental impacts, tourism also plays a significant role in economic growth. Munjal (2013) showed that tourism contributes significantly to GDP and employment in India, while Kozhokulov et al. (2019) found a positive impact of tourism on economic and social growth in the Issyk-Kul region of Kyrgyzstan. On the other hand, Tong et al. (2022) emphasized the importance of understanding the mechanisms underlying the relationship between tourism economics and carbon emission reduction in China. This research suggests that although tourism can drive economic growth, it is also important to consider its environmental impacts and promote sustainable tourism practices.

This study contributes to the literature by offering a comparative approach to evaluating the impact of tourism on economic growth and carbon emissions in high-income and middle-income countries in Asia. In line with Paramati et al. (2018), who compared the economic impacts of tourism in developed and developing countries, this study also uses a similar approach to analyze how tourism affects countries with different income levels. The novelty of this research lies in two main aspects: first, the use of the Seemingly Unrelated Regression (SUR) method to analyze the relationship between economic and environmental variables across countries; second, the perspective taken in comparing high-income and middle-income countries provides in-depth insights into the different dynamics between these two groups of countries. Thus, this research not only enriches our understanding of tourism dynamics in Asia but also provides practical guidance for policymakers in formulating sustainable tourism strategies that are oriented towards inclusive and environmentally friendly economic growth.

Literature Review

In recent decades, tourism has evolved into one of the most dynamic sectors of the global economy, particularly in Asian countries. As one of the main drivers of economic growth, tourism contributes significantly to increasing income, job creation, and infrastructure development. However, on the other hand, rapid tourism growth also poses significant challenges to environmental sustainability, particularly through increased carbon emissions. This literature review will discuss two main aspects: (1) the impact of tourism on the economy, and (2) the impact of tourism on the environment. Through the analysis of empirical and theoretical studies, this review will reveal the complex relationship between tourism, economic growth, and the environmental challenges it faces.

The Relationship Between Tourism and the Economy

Tourism plays a significant role in the economy, particularly in influencing economic growth. This relationship is complex and multi-layered, covering various aspects such as job creation, GDP increase, and infrastructure development. Various studies have examined the interaction between tourism and economic growth with varying results depending on the context and conditions of the country. Antonakakis et al. (2017) investigated the ambiguous relationship between tourism and economic growth, emphasizing the key factors that influence economic and tourism performance. This study provides a comprehensive analysis of various tourist destinations around the world, showing how complex the relationship between tourism and economic development is. In many countries, tourism is considered a major driver of economic growth, particularly in countries that have successfully maximized the potential of this sector through supportive policies.

Tourism has a significant impact on economic growth, with various studies examining the complex relationship between this sector and GDP growth. A study by Qin et al. (2018) through meta-analysis shows how tourism income contributes to economic development in major cities, indicating that income from tourism not only increases GDP but also strengthens long-term economic stability in various major cities. In China, research by Zhang et al. (2021) confirmed the existence of a long-term relationship between the development of the tourism industry and economic growth using the Vector Autoregression (VAR) model. Their findings support the existence of a balanced long-term relationship between tourism development and economic growth, strengthening the concept of tourism-led economic growth. Similarly, Montvydaitė

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(2024) highlighted the role of tourism in post-crisis economic recovery in the Baltic states, emphasizing the importance of this sector in facilitating economic growth during difficult times.

Further research highlights the importance of a strategic approach in managing the interaction between tourism and economic growth. Zhou (2021) used machine learning techniques to predict the impact of tourism income on local economic development, underscoring the importance of a deep understanding of this relationship in urban and rural areas. Additionally, Castro-Nuño et al. (2013) through a meta-analysis of panel data confirmed that tourism serves as a major driver of economic growth, particularly in countries with strong tourism policies and supportive infrastructure. The study by Guan and Guo (2022) also emphasized that the interaction between urban environmental quality and the tourism economy can affect economic outcomes, showing that the success of this sector is highly influenced by how urban environments are managed to support tourism activities. Research by Zhang et al. (2022) on the coordinated development of tourism, economy, and environment along the Silk Road also confirms the importance of a balanced integration of these three elements in the development of sustainable tourist destinations.

However, the research by Katircioglu (2009) re-examined the tourism-led growth hypothesis in Turkey using bounds testing and the Johansen approach for cointegration. This study found that the relationship between tourism and economic growth is not always linear and its impact can be limited if not supported by adequate infrastructure or in unstable economic conditions.

The Relationship Between Tourism and Carbon Emissions

The environmental impact of tourism has become a major focus in research, particularly in the context of sustainability. While tourism provides significant economic benefits, it also brings negative environmental impacts such as increased carbon dioxide (CO2) emissions, ecosystem degradation, and pressure on natural resources. Overall, the existing literature shows that the relationship between tourism, the economy, and the environment is complex and interconnected, particularly through the CO2 emissions generated from the transportation and accommodation sectors, where air transportation is one of the most energy-intensive sources of emissions (Gössling, 2002; Becken & Simmons, 2002). As tourism activity increases, carbon emissions also increase, exacerbating global climate change. Guan and Guo (2022) emphasized the importance of maintaining a balance between tourism economic development and environmental quality, noting that without proper environmental management, tourism can exacerbate urban ecosystem degradation. Lu et al. (2018) warned that without effective policy coordination between the tourism industry and environmental policies, environmental damage can threaten the economic benefits generated from tourism. To address this issue, Borysova et al. (2022) and Guluzade (2023) underline the importance of implementing sustainable practices aligned with the principles of the circular economy to minimize environmental impacts and support the sustainability of tourism in the future.

Research consistently shows that tourism activities contribute significantly to global carbon emissions, with this sector accounting for a substantial portion of greenhouse gas emissions worldwide (Herrero et al., 2022). The carbon footprint of tourism, particularly from transportation, shopping, and food-related activities, has raised significant concerns regarding the sustainability of this industry and its role in climate change. Understanding the sources and intensity of carbon emissions in tourism activities is crucial for developing strategies that can reduce the environmental impact of this industry and promote sustainable tourism practices. Methodologies such as life cycle assessment (LCA) have been used to measure the carbon footprint of tourism at various stages, providing insights into the environmental impact of tourist behavior and consumption patterns (Li, 2023).

Efforts to reduce carbon emissions associated with tourism have led to the implementation of initiatives such as the Glasgow Declaration on Climate Action for Tourism, which aims to significantly reduce the carbon footprint of this sector by setting ambitious targets to reduce emissions by half by 2030 and achieve net-zero emissions by 2050 (Wang, 2024). These initiatives emphasize the importance of decarbonizing the tourism industry to mitigate its environmental impact. Research has highlighted both direct and indirect carbon emissions from tourism, particularly from the transportation and accommodation sectors, which constitute a significant part of the sector's carbon footprint (Youmeng, 2023). Moreover, studies have

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shown that the embodied carbon emissions from inbound tourism can exceed direct emissions, significantly affecting the overall carbon footprint of the industry (Hu, 2022).

To improve the ecological performance of the tourism industry, low-carbon tourism models and environmentally-friendly practices have been developed to reduce emissions and promote sustainable development (Chen et al., 2022). Evaluating the environmental impact of tourism activities through carbon footprint analysis and related indices such as carbon absorption capacity has provided a comprehensive understanding of this industry's contribution to climate change (Ren et al., 2019). Collaborative efforts among stakeholders, including eco-friendly innovations and green consumption practices, are essential to addressing the environmental challenges posed by tourism (Conefrey & Hanrahan, 2022). By integrating low-carbon strategies into tourism operations and supply chains, this industry can reduce its carbon intensity and align with broader climate change mitigation goals.

In conclusion, the above literature review clearly shows that the relationship between tourism, economic growth, and CO2 emissions is not uniform across countries, periods, or estimation methods. Most of the existing literature focuses on the causal relationship between these variables but neglects their dynamic relationship. Specifically, studies examining the relationship between tourism, economic growth, and CO2 emissions simultaneously based on economic development levels (e.g., developed vs. developing countries) are still limited. Therefore, this study is designed to narrow the research gap and thereby contribute to the advancement of the literature as well as provide insights for policymakers.

Research Methods

Model Specification

This research aims to evaluate the impact of tourism on the economy and carbon emissions in high-income and middle-income countries in Asia. This study applies a quantitative approach using panel data for the period 2009-2019 obtained from the World Bank. The objects of this research are high-income countries in Asia, namely Brunei Darussalam, Bahrain, Hong Kong, Japan, South Korea, Singapore, Saudi Arabia, Kuwait, Cyprus, and Israel. These countries were selected because they have easy access, high security, and developed infrastructure, making them prime destinations for tourists. The dataset for these countries was obtained from the World Bank for the research period between 2009 and 2019. The research period is limited to 2019 to analyze the impact of factors related to tourism and other variables before the implementation of global lockdowns due to the COVID-19 pandemic. The data includes GDP, international tourism receipts, total labor force, gross fixed capital formation, total population, internet users, industry value-added, and services value-added.

To achieve the research objectives, two models were developed using existing theoretical approaches. The first model is the neoclassical growth model Sollow-Swan, used to investigate the relationship between economic output, capital, labor, technology, and tourism. The second model is the IPAT model (Ehrlich & Holdren, 1970) used to analyze how tourism affects CO2 emissions, which was later refined into the STIRPAT model (Dietz & Rosa, 1994).

Model 1: Sollow-Swan Growth Model

$GDP_{it} = f(TR_{it}, LF_{it}, GFCF_{it}, TI_{it}, vi)$

Where GDP represents economic output at constant prices. TR is international tourism receipts, LF is the total labor force, GFCF is gross fixed capital formation, and IT is the number of internet users as a percentage of the total population.

Model 2: IPAT Model

$CO2it = f(POPit, TRit, INDit, SRVit, TIit, vi)$

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Where CO_2 represents carbondioxide emissions in metric tons per capita, POP is the total population, TR is international tourism receipts, IND and SRV are the value-added of the industrial and services sectors as a percentage of GDP.

In this study, the term *vi* is employed to represent the individual fixed effects associated with each country, capturing unique, time-invariant characteristics that may influence the dependent variable. The subscripts *i* and *t* denote the specific country and time period under consideration, respectively, with *i* ranging from 1 to N, representing the total number of countries, and *t* ranging from 1 to T, representing the total number of time periods. The data utilized in this analysis is sourced from the World Bank and Our World in Data, ensuring comprehensive and reliable coverage across the relevant countries and time periods.

Estimation Techniques

To examine the impact of tourism on the economy and CO2 emissions, we use panel data analysis combined with the Seemingly Unrelated Regression (SUR) approach. It is often found that errors between different regression models are correlated, making OLS estimation inefficient. One way to address this problem is by using the SUR method, which estimates parameters using Generalized Least Squares (GLS).

Contemporaneous Correlation Test

Contemporaneous correlation test measures the relationship between errors from different equations simultaneously (Dufour, 2002). The SUR test can be performed if the errors between different equations are correlated, or in other words, there is cross-equation correlation between the components ε. The Contemporaneous correlation can be performed using the Lagrange Multiplier test statistic.

In this study, contemporaneous correlation is necessary. Contemporaneous correlation measures the relationship between errors from different equations simultaneously. The SUR test can be performed if the errors between different equations are correlated, or in other words, there is cross-equation correlation between the components *εi*.

Data Characteristics and Measurement

The variables used in this study are measured as follows: CO2 emissions per capita are presented in metric tons, and GDP represents nominal GDP at constant prices in US dollars; GFCF is gross fixed capital formation in current US dollars. TR is the total revenue from international tourism in US dollars; IND is the value-added of the industry as a proportion of GDP; POP is the total urban population in millions; SER is the value-added of the services sector as a percentage of GDP, and IT is the percentage of internet users in the population. The time series data mentioned above were collected from the World Development Indicator (WDI 2023), an online database provided by the World Bank.

Challenges related to the distribution characteristics of the time series data were addressed by transforming nominal data into logarithmic form to normalize the series into a comparable size. Additionally, because the calculated coefficients can be recognized as elasticities, the recommended method is to transform the data into logarithmic format.

Results and Discussion

Descriptive Statistics

Table 1 shows a summary of the sample countries classified by income level. The table shows that the real GDP of middle-income countries has an average GDP of $149 trillion, higher than that of high-income countries with an average of $75.442 billion. However, middle-income countries show greater variation in their GDP, as reflected in a higher standard deviation. This indicates significant economic disparities among middle-income countries, especially from the sample country, China. Carbon emissions per capita also show stark differences between the two country groups. High-income countries have an average carbon emission

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of 1.407 metric tons per capita, while middle-income countries have an average emission of 356 metric tons per capita. The standard deviation of carbon emissions in high-income countries is larger, reflecting considerable variation among countries in this group. In terms of tourism revenue, middle-income countries have an average revenue of $1.667 billion, higher than $1.380 billion in high-income countries. The variation in tourism revenue in middle-income countries is also greater, indicating a significant reliance on the tourism sector as a major source of foreign exchange earnings for some countries in this group.

Table.1 Descriptive Statistic

Variable	***High Income Country***			
	Mean	Maximum	Minimum	Std. Dev.
CO2	14,07	27,78	5,51	6,47
GDP	754.4	4.582,7	12,7	1.280,3
GFCF	192.675,9	1.154.026,3	2.554,9	318.847,1
LF	12.350,9	69.045,5	191,3	19.816,3
TI	79,30	99,70	38,00	14,84
TR	13.799,6	49.209	79.000	13.229,7
POP	85,65	100,00	66,81	9,62
IND	38,24	74,81	6,26	20,02
SRV	59,11	91,92	27,36	16,39
Variable	***Middle Income Country***			
	Mean	Maximum	Minimum	Std. Dev.
CO2	3,56	7,73	0,34	2,56
GDP	1.492,5	14.296,3	2,9	3.140
GFCF	568.549,3	5.999.734.2	621,9	1.328.596,6
LF	156.148,6	780.709,6	133,3	248.248,8
TI	37,84	84,19	0,53	20,98
TR	16.665,1	61.593,9	4,9	15.450,3
POP	47,17	76,61	19,93	16,23
IND	33,34	47,65	8,06	9,84
SRV	50,40	77,93	37,06	9,76

Note: GDP: Real Gross Domestic Product (Billion US$), CO2: Carbon Emissions per capita (Metric tons), GFCG : Gross Fixed Capital Formation (Million US$), LF: Total Labor Force (Million), TR: Tourism Receipts (US$), TI: Technology Utilization proxied by internet users (% of Population), POP: Population proxied by the percentage of urban residents (% of Population), IND: Industry value added (% of GDP), SRV: Services Sector value added (% of GDP).

Contemporaneous Correlation Test

To use both equations within the SUR framework, it is necessary to test whether the errors of both equations are correlated, so regression analysis was first conducted using Ordinary Least Squares (OLS) estimation to test for cross-equation correlation. The following table presents the regression analysis results using the least squares method for the Economy (GDP) and Carbon Emissions (CO2) equations in both country groups.

Table 2. OLS Estimation Model

High Income Countries				**Middle Income Countries**		
	Coefficient	Std.Error	Prob.	Coefficient	Std.Error	Prob.

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C(10)	4.09	0.33	0.00	3.93	0.31	0.00
C(11)	0.06	0.01	0.00	-0.02	0.01	0.17
C(12)	0.33	0.04	0.00	0.15	0.02	0.00
C(13)	0.62	0.03	0.00	0.8	0.02	0.00
C(14)	-0.002	0.001	0.06	0.003	0.0009	0.00
C(20)	-29.42	8.56	0.00	-8.38	2.63	0.00
C(21)	-0.08	0.05	0.09	0.14	0.01	0.00
C(22)	0.51	0.28	0.07	0.28	0.12	0.02
C(23)	0.54	0.06	0.00	-0.02	0.03	0.43
C(24)	0.31	0.08	0.00	-0.002	0.02	0.94
Determinant Residual Covariance 0.14				Determinant Residual Covariance 0.14		
Equation: Log(Gdp)=C(10)+C(11)*Log(Tr)+C(12)*Log(Lf)+C(13) *Log(Gfcf)+C(14)*Ti				Equation: Log(Gdp)=C(10)+C(11)*Log(Tr)+C(12)*Log(Lf) +C(13) *Log(Gfcf)+C(14)*Ti		
R-Squared	0.99			R-Squared	0.99	
Equation: Co=C(20)+C(21)*Pop+C(22)*Log(Tr)+C(23)*Ind+ C(24)*Srv				Equation: Co=C(20)+C(21)*Pop+C(22)*Log(Tr)+C(23)*Ind+ C(24)*Stv		
R-Squared	0.77			R-Squared	0.71	

Source : Source: Secondary Data (Processed), 2024

After obtaining the linear regression equation in the high income country group with the least squares method, the error in the above equation is used to estimate the variance-covariance σij as follows:

$$\begin{bmatrix} 0.0153352 & -0.0752243 \\ -0.0752243 & 9.2571261 \end{bmatrix}$$

Subsequently, the value of λ = 4.384 was obtained. With a significance level of α = 5%, it was concluded that H0 is rejected because λ (4.384) is greater than χ2 (1,0.05) of 3.841, indicating that there is cross-equation correlation between the errors in each equation. This forms the basis for using the SUR model with the Feasible Generalized Least Squares method.

Then from the regression equation in the middle-income country group, the error in the equation can be estimated from the covariance variance σij as below:

$$\begin{bmatrix} 0.02497103 & -0.0693649 \\ -0.0693649 & 1.8377730 \end{bmatrix}$$

Subsequently, the value of λ = 11.53 was obtained. With a significance level of α = 5%, it was concluded that H0 is rejected because λ (11.53) is greater than X^2(1,0.05) of 3.841, indicating that there is contemoraneous correlation between the errors in each equation in the middle-income country group. This forms the basis for using the SUR model with the Feasible Generalized Least Squares method.

SUR Model Estimation

Based on the cross-equation correlation test, estimation was performed using the Seemingly Unrelated Regression (SUR) method in both high-income and middle-income country groups, and the results are as follows:

Table 3. SUR Estimation Model

High Income Countries				Middle Income Countries		
	Coefficient	Std.Error	Prob.	Coefficient	Std.Error	Prob.

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C(10)	4.28	0.32	0.00	3.9	0.30	0.00
C(11)	0.07	0.01	0.00	-0.02	0.01	0.11
C(12)	0.35	0.03	0.00	0.15	0.02	0.00
C(13)	0.60	0.03	0.00	0.81	0.02	0.00
C(14)	-0.001	0.001	0.17	0.003	0.0008	0.00
C(20)	-34.54	8.29	0.00	-8.83	2.56	0.00
C(21)	-0.09	0.05	0.05	0.15	0.01	0.00
C(22)	0.52	0.28	0.06	0.27	0.12	0.02
C(23)	0.59	0.06	0.00	-0.02	0.03	0.40
C(24)	0.38	0.07	0.00	0.002	0.02	0.92
Determinant Residual Covariance 0.13				Determinant Residual Covariance 0.14		
Equation: Log(Gdp)=C(10)+C(11)*Log(Tr)+C(12)*Log(Ak)+ C(13)*Log(Gfcf)+C(14)*Ti				Equation: Log(Gdp)=C(10)+C(11)*Log(Tr)+C(12)*Log(Ak) +C(13)*Log(Gfcf)+C(14)*Ti		
R-Squared	0.99			R-Squared	0.99	
Equation: Co=C(20)+C(21)*Pop+C(22)*Log(Tr)+C(23)*Ind+ C(24)*Srv				Equation: Co=C(20)+C(21)*Pop+C(22)*Log(Tr)+C(23)*Ind+ C(24)*Stv		
R-Squared	0.77			R-Squared	0.71	

Source : Source: Secondary Data (Processed), 2024

Impact of Tourism on GDP

SUR estimation results reveal that tourism has a positive and significant impact on the economy in high-income countries in Asia, such as Brunei Darussalam, Bahrain, Hong Kong, Japan, Singapore, South Korea, Saudi Arabia, Kuwait, Cyprus, and the United Arab Emirates. Increased tourism activity in these regions boosts the economy, as reflected in total GDP. This finding aligns with Sinclair and Stabler's (1997) theory, which states that the large number of tourists and the scale of their expenditures have a significant impact on income, employment, and balance of payments in tourist destinations (analysis results). UNWTO statistics also show that international tourism receipts encompass tourists' spending on transportation, accommodation, food, shopping, and other services, all of which contribute significantly to the GDP of high-income countries (analysis results).

Conversely, in middle-income countries such as China, Indonesia, Malaysia, and Thailand, tourism does not show a significant impact on GDP. The research results indicate that a 1% increase in tourism receipts is associated with a 0.024% decrease in GDP, although this result is not statistically significant ($p > 0.05$). This may be due to various factors such as underdeveloped tourism infrastructure, greater reliance on other economic sectors like manufacturing and agriculture, and a more budget-conscious tourism market segment (analysis results). The tourism sector in middle-income countries tends to attract price-sensitive tourists, such as backpackers, who spend less compared to tourists in high-income countries (analysis results).

Sun et al. (2020) also noted that while the tourism sector in middle-income countries can contribute to the local economy, excessive reliance on this sector often leads to economic volatility and unstable economic impacts (analysis results). For example, although Thailand has a large tourism sector, its contribution to overall GDP is not significant enough to drive stable economic growth, especially when compared to other sectors such as manufacturing and services (analysis results).

Impact of Tourism on Carbon Emissions

Further analysis shows that tourism also has a positive and significant impact on increasing carbon emissions in high-income countries. The estimation results indicate that a 1% increase in tourism activity is associated with a 0.52% increase in carbon emissions ($p < 0.01$). A study by Bojanic & Warnick (2020) supports these findings by showing that tourism significantly contributes to CO_2 emissions, with a greater impact seen in developed countries. Wang & Jia (2023) also emphasize the importance of developing high-

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quality tourism to achieve low carbon emissions, indicating that the nature of tourism activities and infrastructure in high-income countries affects emission efficiency.

In middle-income countries, tourism also shows a positive and significant impact on carbon emissions, with a 1% increase in tourism activity associated with a 0.268% increase in emissions ($p < 0.05$) (analysis results). Sun et al. (2020) highlighted the continuous increase in the global tourism carbon footprint, which is growing at an annual rate of 3.3%, particularly in developing countries where the tourism sector is rapidly expanding. Tsutsumi (2024) noted that greenhouse gas emissions from the tourism industry in major countries reached 12.5% in 2019, with an annual increase of about 4% .

Furthermore, Li (2023) projects that carbon dioxide emissions from the tourism sector will grow at an average annual rate of around 2.5% until 2035, particularly in regions like Shanxi, China (analysis results). Chen et al. (2022) also emphasized the challenges in reducing tourism carbon emissions through technological innovation, showing that despite advances, the rapid growth of the tourism sector may outpace efforts to reduce carbon emissions.

Overall, these findings suggest that while tourism has a positive impact on the economy in high-income countries, this sector also significantly contributes to carbon emissions. In middle-income countries, although the economic impact of tourism is not significant, the sector still makes a considerable contribution to increasing carbon emissions. This underscores the need for more sustainable tourism management strategies to mitigate environmental impacts, especially in developing countries.

Conclusion

This study aims to empirically investigate the role of tourism in economic growth and carbon emissions in high-income and middle-income countries in Asia using a multivariate framework on panel data. The findings provide comprehensive insights into the relationship between tourism, economic growth, and carbon emissions in these two country groups.

In high-income countries, tourism has been proven to have a significant positive impact on economic growth, supported by the sector's contribution to job creation, tax revenue, and foreign exchange reserves. However, increased tourism activity also raises carbon emissions, highlighting the significant challenge of balancing economic growth with environmental sustainability. To address this challenge, high-income countries need to implement innovative low-carbon technology-based tourism policies, such as the use of renewable energy in tourist destinations, the development of environmentally friendly transportation, and the application of efficient waste management systems in the hospitality sector.

In contrast, in middle-income countries, tourism does not have a significant impact on GDP, although the sector contributes to increasing carbon emissions. Infrastructure limitations and lower market segmentation are major obstacles in maximizing the economic potential of tourism. Therefore, these countries are advised to develop tourism economic diversification strategies by utilizing alternative tourism potentials such as ecotourism, cultural tourism, and health tourism, which can not only increase revenue but also minimize environmental impact. Additionally, investment in infrastructure that supports sustainable tourism should be prioritized to drive more inclusive and sustainable economic growth.

To reduce the environmental impact of tourism while supporting economic growth, innovative and technology-based policies need to be adopted. In high-income countries, the implementation of carbon taxes on the tourism sector, incentives for tour operators who adopt environmentally friendly practices, and the development of green building standards for tourism infrastructure can be effective steps. Meanwhile, in middle-income countries, policies should focus on increasing local capacity in destination management, developing environmentally friendly transportation networks, and improving access to clean technology that can reduce the carbon footprint of the tourism sector.

This study opens opportunities for further research that can focus on analyzing the specific impacts of various types of tourism (e.g., ecotourism vs. mass tourism) on the economy and the environment. Future

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research can also explore the impact of low-carbon technology policies in tourism and their effectiveness in different economic contexts. Moreover, longitudinal research tracking changes in economic and environmental dynamics due to policy interventions can provide deeper insights into the long-term sustainability of the tourism sector in various countries.

The Contribution of the Authors

Conception, M.A, S, and A.A.T; literature review, M.A and A.A.T; case study and investigation, S, and M.S; formal analysis, M.A and A.A.T; editing, discussion and conclusion M.A, and M.S.

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ZBADANIE RÓŻNEGO WPŁYWU TURYSTYKI NA GOSPODARKĘ I EMISJĘ DWUTLENKU WĘGLA W KRAJACH O WYSOKIM I ŚREDNIM DOCHODZIE W AZJI

STRESZCZENIE: Niniejsze badanie analizuje podwójny wpływ turystyki zarówno na wzrost gospodarczy, jak i zrównoważony rozwój środowiska w krajach azjatyckich o wysokim i średnim dochodzie. Wykorzystując metodę pozornie niepowiązanej regresji (SUR), badanie analizuje dane panelowe w celu oceny wpływu turystyki na produkt krajowy brutto (PKB) i emisję dwutlenku węgla (CO2). Wyniki pokazują, że turystyka znacząco zwiększa wzrost gospodarczy w krajach o wysokim dochodzie, podczas gdy jej wpływ na kraje o średnim dochodzie jest stosunkowo niewielki. Ponadto stwierdzono, że turystyka znacznie zwiększa emisję dwutlenku węgla w krajach o wysokim dochodzie, przy mniej wyraźnym wpływie na kraje o średnim dochodzie. Wyniki te podkreślają pilną potrzebę opracowania i wdrożenia holistycznej, zrównoważonej polityki turystycznej, która uwzględnia zarówno wyniki gospodarcze, jak i środowiskowe. Chociaż badanie oferuje cenne spostrzeżenia, jego zakres jest ograniczony do krajów azjatyckich, co może ograniczać szersze zastosowanie. Oryginalność tego badania polega na jego integracyjnym podejściu, opowiadającym się za polityką, która zapewnia, że wzrost gospodarczy napędzany turystyką jest zarówno inkluzywny, jak i zrównoważony środowiskowo.

SŁOWA KLUCZOWE: turystyka, gospodarka, emisja dwutlenku węgla, Azja, pozornie niepowiązana regresja (SUR).