



The Dynamics of Tourism, Economic Growth, and CO₂ Emissions in Uzbekistan: An ARDL Approach

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Received: 02 May 2024

Accepted: 29 September 2024

DOI: <https://doi.org/10.32479/ijeeep.16591>

ABSTRACT

In this study, we examined the impact of key macroeconomic variables on the sustainability of tourism in Uzbekistan using open data from the World Bank from 2000 to 2023. The selected variables for the study include the number of international tourists, GDP, CO₂ emissions, and exchange rates. Considering the importance of climate issues in ensuring sustainable tourism, the study combines these factors using the autoregressive distributed lag (ARDL) model to assess their long-term relationships. We chose this model due to its flexibility in dealing with variables of different integration orders. The results of the bounds testing procedure confirm the existence of a long-term cointegration relationship between the dependent variable (international tourist arrivals) and the selected macroeconomic indicators. Specifically, the study results indicate that GDP growth, exchange rate fluctuations, and CO₂ emissions positively affect tourist arrivals to Uzbekistan. The findings of this study underscore the importance of infrastructure development and macroeconomic stability in attracting international tourists while emphasizing the need for sustainable international practices to mitigate environmental impacts. This study contributes to understanding the complex interrelationship between tourism development and macroeconomic variables in the context of developing countries and aids decision-making in this area.

Keywords: CO₂ Emission, Tourism, GDP, Exchange Rate, ARDL

JEL Classifications: P48, Q54, Z3

1. INTRODUCTION

Tourism stands as one of the most dynamic and transformative industries in the global economy, contributing significantly to socio-economic development, cultural exchange, and international cooperation. In recent decades, the tourism sector has experienced unprecedented growth, propelled by factors such as globalization, technological advancements, and changing consumer preferences. As countries strive to harness the potential of tourism for economic prosperity, the concept of sustainable tourism has emerged as a central tenet, emphasizing the need to balance economic growth with environmental conservation and socio-cultural preservation.

Uzbekistan, situated at the crossroads of the ancient Silk Road and boasting a wealth of historical, cultural, and natural attractions, holds immense potential as a tourist destination (Ibadullaev, 2023). With its diverse landscapes, architectural marvels, and vibrant cultural heritage, Uzbekistan offers a unique and enriching experience for travelers seeking to explore its rich tapestry of history and tradition (Ibadullaev, 2023). However, the realization of this potential hinges upon various factors, including macroeconomic stability, infrastructural development, environmental sustainability, and policy support (Saidmamatov et al., 2021).

Against this backdrop, this study sets out to investigate the dynamic interplay between tourism, economic growth, and CO₂ emissions

in Uzbekistan. Drawing on comprehensive data from the World Bank spanning from 2000 to 2023, we seek to unravel the intricate relationships between key macroeconomic variables and tourism development in the country (World Bank, 2023). Specifically, we focus on variables such as the number of international tourists, GDP, CO₂ emissions, and exchange rates, which are pivotal in shaping the tourism landscape and its sustainability. At the heart of our analysis lies the recognition of the critical role played by climate considerations in shaping the trajectory of tourism development. Climate change and environmental degradation pose significant challenges to the sustainability of tourism, threatening the very assets upon which the industry relies (Rajabov et al., 2023). By integrating climate-related factors into our analysis, we aim to elucidate the importance of environmental sustainability in fostering resilient and inclusive tourism growth.

To achieve our objectives, we employ the autoregressive distributed lag (ARDL) model, a robust econometric framework capable of capturing both short-term fluctuations and long-term equilibrium relationships among variables. By leveraging this analytical approach, we endeavor to provide valuable insights into the drivers of tourism growth in Uzbekistan and identify policy implications for promoting sustainable development in the sector. Through our research, we aim to contribute to the growing body of knowledge on tourism economics and sustainable development, offering valuable insights for policymakers, industry stakeholders, and researchers alike. By illuminating the complex interdependencies between tourism, economic growth, and environmental sustainability, we seek to inform evidence-based decision-making processes aimed at fostering inclusive and sustainable tourism development in Uzbekistan and beyond.

2. LITERATURE REVIEW

2.1. Tourism-CO₂

The relationship between tourism and CO₂ have been studied by a number of works so far and some of them find positive correlation while others agree that there is negative relationship. According to Tugcu and Topcu (2018) who studied the impact of CO₂ on tourism in the top ten tourism destinations of the world by employing ARDL for the period 1995-2010, total emissions, emissions from solid fuel (only in the near term), and emissions from liquid fuel have negative effects on tourism receipts, emissions from gaseous fuel have a favorable effect. Koçak et al., (2020) conducted research on the impact of tourism development on environmental degradation, based on empirical findings, it may be inferred that there is a positive correlation between tourism arrivals and CO₂ emissions, but tourism receipts have a negative correlation (Saidmamatov et al., 2024). The findings also suggest a potential causal relationship and co-movement between long-term tourism developments and CO₂ emissions. Although it has the potential to negatively impact the environment, tourism is a major driver of both cultural and socioeconomic advancement. Algieri et al., (2022) examined five potential pathways that could drive CO₂ emissions between 1995 and 2019: tourism, climate, demographics, economy, and technological infrastructure in the case of Italy. The panel data results demonstrate how tourism-related trash and electricity usage raise carbon dioxide emissions.

Similarly, a major factor influencing CO₂ emissions is the tourism development index, which is based on principal component analysis. Voumik et al. (2024) analysed tourism sector's impact on carbon emissions in Asia. According to the study's findings, tourism slows the environment's deterioration. Numerous factors, including population expansion, energy consumption, and economic development, contribute to an increase in CO₂ emissions (Ibadullaev et al., 2024). Only renewable energy sources and tourism can reduce CO₂ emissions. Consequently, the outcomes of the AMG and CCEMG tests corroborate the findings of the CS-ARDL. Globally, the impacts of tourism development on CO₂ emissions appear to be inconsistent.

Le and Nguyen (2020) studied the impacts of tourism on carbon dioxide emissions in countries of arrival by employing a large panel of 95 countries, consisting of three subsamples of countries classified by income level over the period 1998-2014. This study's theoretical framework is based on an expanded version of the STIRPAT model that incorporates the EKC. The following are the empirical findings: (i) Travel reduces overall CO₂ emissions as well as emissions from the production of electricity and heat in the countries where visitors arrive; (ii) travel raises transportation-related CO₂ emissions while increasing CO₂ emissions per visitor; and (iii) the effects of travel on emissions differ depending on income levels. Amelung and Viner (2006) studied the potential impacts of climate change on global tourism and found that climate change could alter tourism patterns and destinations, leading to increased emissions in some regions and decreased emissions in others. Their work underscores the importance of considering climate change in tourism development strategies. Becken et al. (2003) analyzed the environmental impact of tourism in New Zealand, finding that the transportation sector, particularly aviation, was the largest contributor to tourism-related CO₂ emissions. They emphasized the importance of integrating environmental management into tourism planning to reduce emissions. Katircioglu et al. (2014) focused on the Mediterranean region and found a positive correlation between tourism development and CO₂ emissions. Their research suggested that while tourism boosts economic growth, it also increases energy consumption and emissions, highlighting the need for sustainable tourism practices. Dwyer et al. (2010) investigated the impact of tourism on CO₂ emissions in different regions, showing that variations in tourism infrastructure and practices lead to differing environmental outcomes. Their study in Australia indicated that the tourism sector's carbon footprint varies widely depending on the type of tourism activities and the regions' energy sources.

2.2. Tourism-GDP

The tourism industry has long been a subject of extensive research and is essential to the prosperity of many economies across the globe (Kuziboev et al., 2024). The relationship between economic growth and tourism industry have been studied widely. Naseem (2021) examined the relationship between tourism and economic growth, the study used a variety of statistical techniques, including correlation coefficients, unit root tests, Johansen co-integration tests, co-integration regression tests, and Granger causality tests. The findings indicate that, in comparison to other characteristics, the number of tourist arrivals has a substantial correlation with

economic growth. Ohlan (2017) analyzed this relationship in the case of India over the period of 1960-2014, the findings of the recently created Bayer and Hanck combination test show a cointegration between tourism, economic expansion, and financial development. Research indicates that inbound tourism contributes to India's economic growth in both the short and long terms. Furthermore, the study suggests the existence of a long-run, one-way Granger causal relationship between economic growth and tourism. Rasool et al. (2021) carried out research on the relationship between tourism and economic growth among BRICS countries by using the panel data over the period 1995-2015, Long-term cointegration between tourism, financial development, and economic growth is suggested by the panel ARDL cointegration test results. Additionally, the Granger causality study shows that there is a two-way causal relationship between inbound tourism and economic growth, supporting the "feedback-hypothesis" in the BRICS nations. A country's overall economic policy and trade balance have benefited greatly from tourism, as seen by the rising number of foreign visitors to a given destination country, each of which has had a different economic impact. Putri et al. (2023) studied tourism's impact on economic growth in the case of Bali, according to the authors, one tactic being used to lower poverty and boost economic growth is tourism. Increased revenue, the creation of new jobs, economic diversification, the addition of new products, and contributions to the broader economic sector that is integrated to create an enhanced quality of life are all indicators of increased economic growth in the surrounding community. While higher GDP generally promotes tourism, it is essential to acknowledge potential limitations (Wang and Davidson, 2010). Economic growth can sometimes lead to increased costs, including higher prices for goods and services, which may deter budget-conscious tourists. Moreover, rapid economic development can strain existing infrastructure and lead to overcrowding at popular tourist destinations. Therefore, it is crucial for policymakers to balance economic growth with sustainable tourism practices to ensure long-term sector viability (Brida et al., 2016, Tang and Tan, 2015).

2.3. Tourism-exchange Rate

In general, for foreign visitors, tourism products and services must become more affordable if the destination country's exchange rate rises (Saidmamatov et al., 2021). That is to say, foreign visitors can get more products and services for the same price (at a particular currency rate). This may entice visitors from other countries to that nation. According to Adeleye et al. (2022) who studied exchange rate, tourism and economic growth in Asia by using a moderation modelling framework, economic growth is positively impacted by tourism but negatively impacted by exchange rate depreciation also the interaction effect is positively impacted but not statistically significant and there are mixed results from the EAP and SA samples. Rookayyah et al. (2024) use a panel autoregressive distributed lag model with annual data covering the years 1999-2019 to examine the effects of currency rates and exchange rate volatility on incoming tourism demand in Mauritius. The findings indicate that, over the long term, domestic income has a positive and significant impact on tourism demand, while the exchange rate and its volatility have negative and significant effects on demand for travel across the three samples examined. Sarchami

et al. (2021) analyzed this in the case of Iran by developing a vector autoregressive (VAR) model and found out that Iran's tourism revenue was significantly impacted by the exchange rate as well as composite factors related to the economy, politics, culture, infrastructure, and environment. Both the bilateral exchange rate and the US dollar exchange rate in relation to the countries of origin of tourism are significant drivers of international tourist flows, according to the exchange rate elasticities of international tourism study by Ding and Timmer (2023). In addition, country-specific dominant currencies (CSDCs) play only a minor role on average but are important for tourism-dependent countries and those with a high concentration of foreign tourists across origin countries. They stated that the U.S. dollar exchange rate is more important for tourism destination countries with higher U.S. dollar borrowing, pointing to a complementarity between U.S. dollar pricing and financing. Rafiei and Abbaspoor (2021) analyzed the impact of exchange rate on domestic tourism in the case of Iran and stated that in order to do this, domestic tourism is added as a separate sector to the social accounting matrix, which is then fed into a CGE model. The findings indicate that all households' demand for domestic travel declines when the exchange rate increases by 50%. Nonetheless, several industries' exports have improved. Increased inbound tourism is also reflected in the hotel sector. It is advised to research all facets of exchange rate policies because the effects of the increase in exchange rates are not uniform in all areas.

3. METHODOLOGY

In this study, data from the World Bank covering the period from 2000 to 2023 was utilized. We selected variables such as the number of international tourists visiting the country and factors that could influence it, including GDP, CO₂ emissions, and exchange rates. Incorporating climate issues into the core set of concerns is also possible for achieving sustainable tourism, as it is not only an ecological issue but also crucial for Uzbekistan's development.

In our research, we analyzed the dynamics of tourism sustainability in Uzbekistan using the ARDL (Autoregressive Distributed Lag) model proposed by Pesaran and Shin (Jeong et al., 2023). It is crucial to emphasize why the ARDL model aligns with our data. Firstly, the ARDL approach is suitable for our data due to its ability to accommodate the integration order of variables. Unlike other cointegration methods, the ARDL model can handle combinations of basic regressors, such as I(0), I(1), or both. Considering the potential integration characteristics of macroeconomic time series data, such as GDP, exchange rates, and CO₂ emissions, is essential for ensuring the validity of our analysis.

For our analysis, we selected a total of four variables: tourist arrivals, GDP, exchange rates, and CO₂ emissions. The bounds testing procedure determines the presence of long-term relationships among the selected explanatory variables through upper and lower critical values. If the computed F-statistic exceeds the upper critical value, we can confidently conclude the existence of long-term cointegration. Conversely, if the F-statistic falls below the lower critical value, the presence of long-term cointegration is rejected. Finally, if the F-statistic is

between the critical values, we fail to reject the null hypothesis of no cointegration among the parameters. The hypotheses of the bound test are as follows:

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0 \tag{1}$$

$$H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0 \tag{2}$$

After confirming the presence of long-term cointegration, we can proceed to estimate the (3) equation based on the ARDL approach to examine the long-term relationships among the variables (Jong et al., 2022).

$$\begin{aligned} \Delta \ln LTA_t = & a_0 + \sum_{i=1}^P a_1 \Delta \ln LTA_{t-i} + \sum_{i=1}^P a_2 \Delta \ln LGDP_{t-i} \\ & + \sum_{i=1}^P a_3 \Delta \ln LEXC_{t-i} + \sum_{i=1}^P a_4 \Delta \ln LCO_{2t-i} + \lambda_1 \ln LTA_{t-1} \\ & + \lambda_2 \ln GDP_{t-1} + \lambda_3 \ln LEXC_{t-1} + \lambda_4 \ln LCO_{2t-1} + \varepsilon_t \end{aligned} \tag{3}$$

In the study, we expressed all variables in logarithmic form. LTA represents the number of international tourists visiting the country; LGDP denotes the total domestic product; LEXC stands for the exchange rate; and L CO₂ represents carbon emissions in Uzbekistan. After identifying long-term relationships in the analysis, it is essential to examine short-term causality and determine the speed of adjustment of the model. In Table 1, we provided descriptive statistical results for the selected variables to analyze tourism sustainability in Uzbekistan.

4. RESULTS AND DISCUSSION

In Table 2, we presented the empirical results of testing the ARDL bounds. Accordingly, the computed F-statistic value (9.01) exceeds the upper critical values recommended by Pesaran and others, as well as Narayan, at all levels of significance. This indicates that we reject the null hypothesis of no relationship. Therefore, we can confirm the presence of long-term cointegration between the dependent variable (the arrival of foreign tourists) and the selected independent variables, indicating their influence.

In the next section of the analysis, we examine the ARDL model and the diagnostic tests underlying it. In Table 3, we presented the empirical results of long-term relationships evaluated by the ARDL (2, 2, 1, 0) model used in our study. The identified empirical values indicate that the number of international tourists (LTA) exhibits statistically significant and positive relationships with GDP, Exchange Rates, and CO₂ emissions as independent variables. This can be interpreted as follows: as infrastructure development and construction increase in the country, the emission of carbon dioxide may be expected to rise, potentially leading to the creation of a more favorable environment for attracting tourists to Uzbekistan. This scenario warrants careful consideration. Overall, the development of the tourism industry may have a direct or indirect impact on carbon emissions, particularly through the involvement of airlines and the hospitality sector.

Table 1: Descriptive statistics

Indicator	LTA	LGDP	LEXC	LCO ₂
Mean	14.11	24.34	7.85	11.68
Median	14.18	24.75	7.45	11.69
Max	15.72	25.23	9.71	11.77
Min	12.35	22.99	4.94	11.50
Standard Deviation	1.06	0.8	1.32	0.07
Skewness	-0.96	-0.54	-0.11	-0.72
Jarque-Bera	0.96	2.94	0.56	2.11

Table 2: Bound test results

Significance level	Pesaran critical values		Narayan critical values	
	Lower bound	Upper bound	Lower bound	Upper bound
90%	2.37	3.2	2.618	3.532
95%	2.79	3.67	3.164	4.194
99%	3.65	4.66	4.428	5.816

F-statistics=9.01 (K=3)

Table 3: ARDL and diagnostic tests results

LTA	
Constant	-48.06 (0.01)
LGDP	1.07 (0.00)
LEXC	0.21 (0.04)
LCO ₂	2.93 (0.02)
ECT	-1.30 (0.00)

Next, we will verify these identified values through diagnostic tests. Firstly, we conduct the RESET test, which is used to determine whether there are omitted nonlinear terms in our model that could influence the dependent variable. The results indicate that the F-statistic value is 0.71 with a P = 0.41. This suggests that we cannot reject the null hypothesis, indicating no evidence of misspecification at the 5% significance level.

Next, we evaluate heteroskedasticity using the Breusch-Pagan-Godfrey test. The results show an F-statistic value of 1.42 and a P = 0.27. It is noteworthy that the p-value exceeds the significance level of 0.05. Thus, we fail to reject the null hypothesis of homoscedasticity. Additionally, there is insufficient evidence to conclude that the variance of errors is not constant across different levels of independent variables.

Furthermore, considering the results of the Breusch-Godfrey serial correlation test, we observe an F-statistic of 1.44 with a P = 0.27. This suggests that there is insufficient evidence to conclude that errors in the model are serially correlated over time.

It appears that significant efforts are underway to develop tourism in Uzbekistan in the coming years. The research results indicate that a 1% increase in carbon emissions leads to a 2.93% increase in tourist arrivals in Uzbekistan (Egamberdieva, 2023). Therefore, the findings suggest a positive impact of CO₂ emissions on the sustainable growth of tourism in Uzbekistan. This is because infrastructure development and the construction of hotels are necessary to attract foreign tourists, which in turn initially leads to an increase in CO₂ emissions (Hoogendoorn and Fitchett, 2019).

Additionally, the research findings reveal positive and significant relationships between tourist arrivals, LGDP, and LEXC in Uzbekistan (Table 3). The positive correlation of GDP growth with tourist arrivals suggests that a 1% increase in total domestic product leads to a 1.07% increase in tourist arrivals, indicating the potential for economic growth to positively influence tourism sustainability and its expansion.

Overall, the relationship between CO₂ emissions and inbound tourism is complex, influenced by various factors that need to be emphasized. Similarly, in Mexico, a positive correlation between CO₂ emissions and tourist arrivals has been identified, where a 1% increase in CO₂ emissions leads to a 0.04% increase in tourism (Khan et al., 2023). While initial infrastructure development for tourism sustainability may lead to increased CO₂ emissions, adopting renewable energy and promoting eco-friendly tourism practices can help mitigate environmental impacts and support long-term tourism growth (Raihan et al., 2022).

Furthermore, exchange rates also play a significant role in influencing the travel decisions of foreign tourists. An increase in the value of the local currency makes international tourism expenses cheaper, thus potentially increasing tourists' purchasing power and encouraging them to travel abroad. The analysis reveals that a 1% appreciation of the currency in Uzbekistan leads to a 0.21% increase in the number of tourists. Moreover, the speed of adjustment to long-term equilibrium, represented by the ECT coefficient of -1.30 in the model, indicates that the tourism industry in Uzbekistan needs to converge towards equilibrium at a rate of approximately 130% after an economic shock. This suggests that following an economic shock, the tourism industry in Uzbekistan should adjust rapidly to achieve long-term equilibrium.

Finally, the model underwent several diagnostic tests. The results indicate that the empirical model is well-specified from a statistical standpoint, with residuals exhibiting normal distribution, good fit, and little to no serial correlation.

5. CONCLUSION

Today, many countries are paying serious attention to climate change and its impact on the sustainability of the tourism sector. Climate change and carbon emissions are deep-seated issues, and at the same time, great opportunities are being created to further expand the development of renewable energy to increase energy efficiency and minimize CO₂ emissions. Ultimately, the tourism industry must align with new policies and regulations implemented by governments as well as the 2030 Sustainable Development Agenda carried out by UN members.

In this study, we used the ARDL model to evaluate the long-term and short-term dynamics between international tourist arrivals, GDP, exchange rates, and CO₂ emissions. According to the study results, the bounds test results indeed confirmed long-term cointegration relationships between international tourist arrivals and macroeconomic variables. The F-statistic value of 9.01 exceeds the critical values at all significance levels, indicating a robust long-term association. This indicates that changes in

GDP, exchange rates, and CO₂ emissions have a consistent impact on the number of tourists coming to Uzbekistan. Additionally, the study results show a statistically significant and positive relationship between GDP and tourist arrivals. A 1% increase in GDP is associated with a 1.07% increase in tourist arrivals. This underscores the importance of economic growth in enhancing Uzbekistan's attractiveness as a tourist destination. Improving economic conditions lead to better infrastructure, services, and overall tourist experiences, attracting more international visitors.

The study results also identified a positive correlation between exchange rates and tourist arrivals. A 1% appreciation in the local currency leads to a 0.21% increase in tourist arrivals. This finding indicates that the strengthening of the national currency makes travel to Uzbekistan more affordable for foreign tourists, increasing their purchasing power and making the destination more appealing.

Interestingly, the analysis shows a positive relationship between CO₂ emissions and tourist arrivals, with a 1% increase in CO₂ emissions leading to a 2.93% increase in tourist arrivals. This result may reflect the initial stages of infrastructure development and the increase in economic activity associated with tourism growth, which tends to increase CO₂ emissions. While this finding highlights the economic benefits of development, it also emphasizes the need for sustainable practices to balance growth with environmental protection.

In conclusion, this study determined that macroeconomic variables have a significant impact on the sustainability of tourism in Uzbekistan. The positive relationships between GDP, exchange rates, CO₂ emissions, and tourist arrivals underscore the importance of economic growth and infrastructure development in attracting international visitors. At the same time, the findings also emphasize the necessity of sustainable practices to mitigate environmental impacts and ensure the long-term viability of the tourism sector. Policymakers and stakeholders need to adopt a balanced approach that promotes economic development while preserving the environment, thereby achieving sustainable growth in tourism in Uzbekistan.

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