

# Do shocks to tourism receipts have a transitory or persistent nature? A comparison of traditional and artificial intelligence-based analytical procedures

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## Abstract

The goal of this study is to determine whether the effects of shocks to tourism receipts and GDP are transitory or permanent in 10 major tourism destinations (Australia, Germany, Italy, Japan, Mexico, Poland, Portugal, South Korea, Switzerland, and the US) using data from 1995 to 2022. The study initially employs unit root tests that employ a variety of methods for modeling structural breaks, then performs a unit root test that is based on artificial intelligence. According to the results of the artificial intelligence-based unit root test, the effects of shocks to tourism receipts are transitory in Italy, Japan, and Mexico, while the effects of shocks to GDP are temporary in Australia, Poland, and Switzerland. The study provides policy recommendations for the tourism and hospitality sector and GDP in countries where the impacts of shocks are enduring.

## Keywords

tourism receipts, shocks, persistency, transience, unit root testing, artificial intelligence, structural breaks

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## Introduction

Tourism is a crucial driver of economic growth worldwide and is often at the center of economic strategies. It offers many benefits, such as creating jobs, increasing income levels, increasing tax revenues, and improvements in trade balances through international tourism (Dogru et al., 2020). In 2019, the tourism industry contributed around 10.3% to global GDP and employed 330 million people. This substantial contribution highlights the sector's importance to global economies. The development of tourism infrastructure plays a vital role in enhancing economic activities, as it generates new jobs and fosters a rise in national income levels (Haini et al., 2024). Tourism has shown strong growth, even outpacing the overall global economic growth rate in some years. This growth is linked to positive effects like more jobs, higher household income, and greater government tax revenues (Saboori et al., 2023). Furthermore, inbound tourism has become increasingly important for sustainable long-term economic growth. It not only helps bolster foreign exchange reserves but also stimulates investment in infrastructure, boosts industrial development, and creates positive externalities, such as improved services and technology advancements (Rasool et al., 2021). As countries continue to prioritize tourism development, the sector holds significant potential to drive economic expansion and foster long-term prosperity.

Notwithstanding its economic significance, tourism demand is affected by numerous factors. Research indicates that tourism demand is influenced by many variables including output, inflation, financial development, openness, exchange rates, climatic conditions, quality of goods and services, institutional factors, etc (see e.g., Bulut et al., 2020; Dogru et al., 2021, among others). Furthermore, tourism is highly vulnerable to various global shocks. These include economic crises, geopolitical risks, policy uncertainties, and natural disasters, which can disrupt the stability of the sector. Unlike other industries, tourism is particularly sensitive to sudden shifts in demand and revenue, as it heavily depends on a secure and stable environment. Economic downturns, such as the global financial crisis in 2008, demonstrate how shifts in global GDP and household consumption can significantly reduce tourism demand, affecting both international arrivals and domestic tourism (Eugenio-Martin and Campos-Soria, 2014). Indeed, numerous studies have demonstrated that international tourism is a luxury good and that the income elasticity of international tourism demand is greater than unity (Kim et al., 2012; Menegaki et al., 2020; Peng et al., 2015; Wang et al., 2022; Ziramba and Moyo, 2013). Furthermore, geopolitical risks, including political violence, military conflicts, and terrorism, can create long-term safety concerns for travelers, leading to cancellations and delays (Hamida, 2024). The COVID-19 pandemic further exacerbated these vulnerabilities, highlighting the industry's fragility in the face of global crises (Kocak et al., 2023a). Moreover, the close connection of tourism with the macroeconomic structure shows that shocks experienced in this sector are not limited to tourism alone, but can also have effects on sub-sectors, such as transportation, construction, retail trade, and restaurants (Yucel, 2021). Tourism performance, therefore, depends on a stable and predictable environment in terms of both security and economic conditions (Kocak and Cobanoglu, 2024).

Tourism, as a sector generating significant economic and social impacts, exhibits high sensitivity to shocks. Understanding the sector's response to shocks is a cornerstone for ensuring sustainability and supporting long-term economic stability. Whether shocks in the tourism and hospitality sector have permanent or temporary effects is critical not only for its current performance but also for enhancing its future resilience. Temporary shocks can be mitigated by the sector's natural recovery capacity, whereas permanent shocks may cause deeper and prolonged damage. Hence, accurately identifying the nature of shocks is vital to determine the necessary policy interventions. Permanent shocks require long-term support strategies to accelerate recovery and ensure sustainability, while

temporary shocks can often be addressed through short-term flexible policies and rapid response mechanisms (Husein, 2024; Payne et al., 2023). Assessing the impacts of these shocks also presents an opportunity to develop strategies that advance not only the economic but also the social and environmental sustainability of tourism. Such analyses, which consider the sector's fragile nature, provide a crucial knowledge base for researchers and policymakers (Payne and Lee, 2024).

Unit root testing is one of the most effective methods for determining whether the impacts of the shocks in the tourism and hospitality sector are permanent or temporary, as it tests the stationarity of time series variables, enabling an understanding of the long-term effects of shocks. If a time series exhibits a unit root process meaning it is not stationary, it indicates that the shocks have permanent effects and that the series will not return to the mean over time. For instance, if the number of foreign tourist arrivals follows a unit root process, it signals external shocks, such as the COVID-19 pandemic, have lasting and long-term impacts on the sector. In this case, the government may need to develop long-term strategies to accelerate recovery (Peng et al., 2024). On the other hand, if the time series behaves like a stationary process, the effects of the shocks are temporary and can dissipate through the sector's natural recovery capacity (Payne and Nazlioglu, 2023). In such cases, short-term flexible policy interventions and rapid response mechanisms will suffice. Hence, unit root testing is a critical tool not only for understanding the nature of shocks in the tourism and hospitality industries but also for formulating appropriate policy responses. Researchers should determine the stationarity levels of the series to model the long-term effects of changes in the sector and, based on this, develop strategies to guide tourist demand. In doing so, policymakers can identify the correct intervention strategies to ensure the sector's economic and social sustainability (Peng et al., 2024).

Recent research has examined whether shocks to international tourism receipts or the number of international tourist arrivals have permanent or transitory consequences through unit root tests (see e.g., Baig and Hussain, 2020; Gil-Alana et al., 2020; Lorde et al., 2008; Payne and Nazlioglu, 2023; Payne and Lee, 2024; Yucel, 2021). The outcomes of these papers vary based on the sample and methodology employed. The key issue here is that earlier research has largely concentrated on structural breaks in the series and none of them have applied an artificial intelligence (AI)-based approach. Hence, there is a notable research gap regarding AI-based unit root analyses. These analyses are considered more robust because these algorithms can uncover hidden patterns and relationships within large datasets more effectively than traditional methods. Traditional statistical methods rely on specific assumptions, such as normal distribution and constant variance, and limited modeling techniques, while machine learning (ML), a type of AI, algorithms can handle more complex structures and model nonlinear relationships and dynamic patterns in time series data better. Stated differently, ML-enabled analytical tools have been suggested as effective in processing vast amounts of data quickly and accurately, allowing researchers to uncover new insights and efficiently identify complex patterns (Dogru et al., 2024). Furthermore, ML improves model generalization through techniques like feature engineering, cross-validation, and avoiding overfitting, leading to more reliable results. These algorithms also learn from past data and provide more accurate predictions with future data. This is especially crucial for analyzing tourism shocks, which are influenced by many factors.

The goal of this study is to investigate the permanence or transience of the impacts of a shock to tourism receipts in 10 major tourism destinations (Australia, Germany, Italy, Japan, Mexico, Poland, Portugal, South Korea, Switzerland, and the USA) for the period 1995–2022. Furthermore, the study examines whether the effects of shocks to GDP are permanent or temporary in these countries to compare the effects of shocks to tourism receipts and GDP. The study first uses the unit root tests developed by Dickey and Fuller (1981, hereafter ADF), Narayan and Popp (2010, hereafter N&P), and Enders and Lee (2012, hereafter E&L). The N&P and E&L techniques adopt different

approaches for modeling structural breaks in series. Then, the study employs the unit root test proposed by [Yaya et al. \(2021\)](#), which is derived from the autoregressive neural network (ARNN) paradigm, a subset of AI and ML methodologies. Consequently, the primary strength of this study lies in its pioneering examination of whether the impacts of shocks to tourism receipts are transitory or permanent, employing an AI-based unit root test.

The rest of the paper is as follows: The following section presents a review of empirical studies. The next section gives the data set and methods. The subsequent section reports the results while the last section concludes the paper.

## Literature review

A review of prior research on the temporary or permanent impacts of shocks on the tourism and hospitality sectors indicates that a substantial number of studies concentrated on the number of tourist arrivals. Furthermore, one study focused on the impacts of shocks on tourism expenditures and receipts. For instance, [Lorde et al. \(2008\)](#) employed univariate and panel unit root tests to examine whether shocks to tourist arrivals in Barbados had permanent or temporary impacts. Their findings indicated that the shocks had permanent impacts on tourist arrivals to the island. [Baig and Hussain \(2020\)](#) used univariate and Lagrange Multiplier (LM) unit root tests with two structural breaks to determine whether shocks to visitor inflows were permanent or transitory. The results rejected the null hypothesis of a unit root for all major source markets, indicating that shocks to the growth path of tourist arrivals had transitory effects rather than permanent ones. The findings of this research conducted by [Gil-Alana et al. \(2020\)](#) suggested that the series of UK arrivals and departures exhibited significant time trends and high persistence, indicating long-lasting effects of shocks. While seasonality was essential, removing it through seasonal differentiation eliminated the time trends but left persistence as a key data feature. [Yucel \(2021\)](#) examined whether shocks to the tourism sector had permanent or transitory effects on tourist arrivals by employing panel unit root tests with and without structural breaks. He concluded that tourist arrivals exhibited stationarity in the presence of sharp structural breaks, meaning the effects of shocks were transitory. By introducing new panel stationarity tests that simultaneously account for structural breaks and a common factor structure, [Payne and Nazlioglu \(2023\)](#) investigated two key variables in a country's balance of payments: per capita international tourism expenditures and per capita international tourism receipts. Their study represents the most extensive multi-country analysis in this field. The findings indicated the shocks to per capita international tourism receipts and expenditures had permanent impacts for most of the countries in the data set. Finally, [Payne and Lee \(2024\)](#) extended the existing literature on the permanent or transitory nature of shocks to tourist arrivals considering both sharp and smooth breaks. Their findings indicated that the impacts of the shocks to tourist arrivals were permanent in most of the countries.

It should be reminded that none of the previously conducted research on the impacts of shocks to tourism receipts performed a unit root test based on AI. Consequently, a principal strength of this paper is its pioneering examination of AI-based methodologies in determining whether the shocks to the tourism sector have permanent or transitory effects.

## Data set and methodology

### Data set

This study focuses on tourism receipts and GDP in 10 major tourism destinations. The selection of tourism destinations is based on tourism receipts in 2022, and to work with as long a data set as possible, some countries with no publicly available data in some years are excluded from the sample. Accordingly, the 10 tourism destinations that constitute the data set of the study are as follows: Australia, Germany, Italy, Japan, Mexico, Poland, Portugal, South Korea, Switzerland, and the USA. The research employs annual tourism receipts (current US dollar) and GDP (constant US\$2015) data from 1995 to 2022. Data for tourism receipts and GDP are extracted from the [OECD \(2024\)](#) and the [World Bank \(2024a\)](#).

### Methodology

Since [Perron's \(1989\)](#) observation that traditional unit root tests do not account for structural breaks in series in the modeling process, many unit root tests have been devised to consider structural breaks. Although the initial tests concentrated on sharp breaks in series, more recent tests have considered both sharp and smooth/gradual breaks in the series. Furthermore, ML-based unit root tests have been implemented extensively recently. This paper first performs the conventional ADF test. Then, it employs the N&P test incorporating sharp structural breaks and the E&L test encompassing both sharp and smooth structural breaks. Finally, it uses the test suggested by [Yaya et al. \(2021\)](#) utilizing ML techniques.

**N&P unit root test.** N&P (2010) formulated a unit root test incorporating two sharp breaks. They first used the following data-generating process:

$$y_t = d_t + u_t \quad (1)$$

where  $d_t$  and  $u_t$  respectively denote the deterministic component and the stochastic component. Besides,  $u_t$  follows an AR(1) process. The regression model with two sharp breaks is illustrated below:

$$d_t = \alpha + \beta t + \psi^*(L)(\theta_1 DU_{1,t} + \theta_2 DU_{2,t} + \gamma_1 DT_{1,t} + \gamma_2 DT_{2,t}) \quad (2)$$

where break dates are  $T_{B,i}$ .  $DU_{i,t}$  and  $DT_{i,t}$  respectively denote the breaks in intercept and trend. The following model is used for unit root testing:

$$y_t = \rho y_{t-1} + \alpha^* + \beta^* t + \Omega_1 D(T_B)_{1,t} + \Omega_2 D(T_B)_{2,t} + \theta_1^* DU_{1,t-1} + \theta_2^* DU_{2,t-1} + \gamma_1^* DT_{1,t-1} + \gamma_2^* DT_{2,t-1} + \sum_{j=1}^k \beta_j \Delta y_{t-j} + e_t \quad (3)$$

The null hypothesis (NH) argues the presence of a unit root with  $\rho = 1$ , whereas the alternative hypothesis claims that  $\rho < 1$ . To reject the NH of a unit root, the test statistic must exceed the critical values.

*E&L unit root test.* E&L suggested a unit root test based on the Fourier approximation to capture both sharp and smooth breaks. E&L first utilized the model defined as follows:

$$y_t = \alpha(t) + \rho y_{t-1} + \gamma t + \varepsilon_t \quad (4)$$

where  $\alpha(t)$  is the deterministic function for  $t$ . Then, they used the following Fourier approach:

$$\alpha(t) = \alpha_0 + \sum_{k=1}^n \alpha_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^n \beta_k \cos\left(\frac{2\pi kt}{T}\right) \quad (5)$$

where  $T$ ,  $k$ , and  $n$  respectively denote the number of observations, the particular frequency, and the number of frequencies. Afterward, they employ the following model for unit root testing under a singular frequency:

$$\Delta y_t = \rho y_{t-1} + c_1 + c_2 t + c_3 \sin(2\pi kt/T) + c_4 \cos(2\pi kt/T) + e_t \quad (6)$$

where  $k$  and  $t$  respectively stand for the singular frequency and the trend. E&L assessed the NH of a unit root, characterized by  $\rho = 0$ , by comparing the test statistic with the crucial values. The NH is rejected when the test statistic exceeds critical values.

*Yaya et al. (2021) Unit root test based on machine learning.* In recent years, the ARNN model, a form of ML methodology, has been implemented in the modeling of economic and financial time series (De Gooijer and Hyndman, 2006). The ARNN model's superiority over conventional time series approaches was supported by certain research findings (see e.g., Boyacioglu et al., 2009; Falat and Pancikova, 2015, among others). As Yaya et al. (2021) and Caglar et al. (2024) stress, the ARNN model offers a superior and more adaptable framework compared to linear and other linear models as it considers all possible functions. Besides, given its data-driven nature and independence from prior views about the functional form, this method effectively generates nonlinear models that capture the intrinsic nonlinearity and reasonability of various nonlinear functional representations in time series. This paper employs the unit root test that is derived from the ARNN model and was propounded by Yaya et al. (2021). This innovative test is designated the ARNN-ADF unit root test, as it is based on the augmented Dickey-Fuller (ADF) unit root test. The regression model for this test is delineated below (Yaya et al., 2021):

$$\Delta y_t = \alpha + \beta t + k_1 \rho y_{t-1} + k_{11} y_{t-1}^2 + k_{111} y_{t-1}^3 + \sum_{j=1}^q z_j \Delta y_{t-j} + \varepsilon_t \quad (7)$$

where  $\alpha$ ,  $t$ ,  $z$ , and  $q$  represent the constant, the trend, the augmentation coefficient, and the optimal lag length determined by an information criterion. Additionally, the coefficients for the linear, nonlinear, and cubic parts are denoted by  $k_1$ ,  $k_{11}$ , and  $k_{111}$ , respectively. If the test statistic exceeds the critical values derived from Monte Carlo simulations, the NH of a unit root is rejected, indicating that the series in question is stationary.

## Results

Table 1 demonstrates the results of the unit root tests for tourism receipts. It should be reminded that the rejection of the NH means the stationarity of tourism receipts and indicates the effects of the shocks are transitory. Accordingly, the NH of a unit root is rejected for (i) Australia, Italy, Japan,

Mexico, Poland, and Portugal according to the ADF test, (ii) Italy, Poland, and Portugal by the N&P test, (iii) Australia, Italy, Mexico, and Portugal according to the E&L test, and (iv) Italy, Japan, and Mexico with regard to the ARNN-ADF test. The results indicate two significant facts. First, unit root tests have varying outcomes. Second, different approaches in modeling structural breaks lead to various findings. Third, the ARNN-ADF test, recognized for its superior efficacy, indicates that tourism receipts exhibit stationarity just in Italy, Japan, and Mexico. Stated differently, shocks to tourism receipts have transitory effects only in these countries.

**Table 1.** Unit root tests for tourism receipts.

Country	ADF	N&P	E&L	ARNN-ADF			
				Test stat	1% critical value	5% critical value	10% critical value
Australia	-3.58***	-3.40	-4.21***	-0.78	-5.55	-3.70	-2.73
Germany	0.23	-3.90	-5.56*	-1.51	-4.15	-2.94	-2.39
Italy	-4.04**	-5.88**	-6.13*	-3.13***	-4.74	-3.25	-2.49
Japan	-3.73**	-3.67	-3.33	-4.92**	-5.83	-3.40	-2.86
Mexico	-4.22**	-2.91	-4.17**	-2.80***	-4.92	-3.18	-2.44
Poland	-4.17**	-6.33*	-2.48	1.50	-3.75	-2.85	-2.36
Portugal	-3.68**	-5.46**	-3.90**	-2.22	-4.76	-2.95	-2.38
South Korea	-2.88	-2.16	-2.59	-2.25	-4.58	-3.16	-2.46
Switzerland	-0.49	1.29	-3.78	-1.27	-4.72	-3.01	-2.46
USA	-2.92	1.83	0.32	-2.04	-5.18	-3.14	-2.59

Notes: For the N&P test, 1%, 5%, and 10% critical values are -5.94, -5.18, and -4.78, respectively. The detected frequency results for the E&L test are available upon request. Critical values for the E&L test vary based on the detected frequency. See Table 1a in E&L (2012: 197) for critical values.  $p < .01$ . \*\* $p < .05$ . \*\*\* $p < .10$ .

**Table 2.** Unit root tests for GDP.

Country	ADF	N&P	E&L	ARNN-ADF			
				Test stat	1% critical value	5% critical value	10% critical value
Australia	-5.82*	-5.62**	-4.08**	-3.10***	-4.60	-3.61	-3.03
Germany	-3.49***	-4.11	-2.68	-0.05	-4.22	-3.14	-2.47
Italy	-2.41	-5.72**	-3.09	0.89	-4.42	-2.81	-2.27
Japan	-2.96	-2.58	-2.83	-0.88	-4.22	-2.94	-2.35
Mexico	-3.11	-2.57	-3.54***	0.90	-4.51	-3.08	-2.45
Poland	-0.65	-2.67	-4.30***	-3.53**	-4.61	-3.40	-2.64
Portugal	-2.41	-4.39	-4.65**	-2.33	-4.03	-2.97	-2.39
South Korea	-3.29***	-4.45	-3.76	-1.82	-4.41	-3.14	-2.52
Switzerland	-3.64**	-4.43	-3.27	-2.55***	-4.19	-3.10	-2.53
USA	-2.30	-4.52	-5.59*	-0.80	-4.26	-3.17	-2.65

Notes: For the N&P test, 1%, 5%, and 10% critical values are -5.94, -5.18, and -4.78, respectively. The detected frequency results for the E&L test are available upon request. Critical values for the E&L test vary based on the detected frequency. See Table 1a in E&L (2012: 197) for critical values.  $p < .01$ . \*\* $p < .05$ . \*\*\* $p < .10$ .

The unit root tests' outputs for GDP are illustrated in [Table 2](#). Consequently, the NH of a unit root is rejected for (i) Australia, Germany, South Korea, and Switzerland by the ADF test, (ii) Australia and Italy according to the N&P test, (iii) Australia, Mexico, Poland, Portugal, and the USA with regard to the E&L test, and (iv) Australia, Poland, and Switzerland by the ARNN-ADF test. The results obtained for the stationarity of GDP, as with the stationarity of tourism receipts, indicate two critical facts. First, unit root tests yield disparate results. Second, various methods of modeling structural breaks result in different results. Third, the ARNN-ADF test, noted for its enhanced effectiveness, reveals that GDP is stationary only in Australia, Poland, and Switzerland. Put differently, shocks to GDP have transitory effects only in these countries.

## Conclusion

Following the COVID-19 pandemic, AI technologies have increasingly been implemented in the tourism and hospitality sectors ([Knani et al., 2022](#); [Saputra et al., 2024](#); [Song et al., 2024](#); [To and Yu, 2025](#)). Some research indicates that the implementation of AI technologies will enhance the economic efficiency of the tourism and hospitality sector ([Huang and Gursoy, 2024](#); [Xu et al., 2023](#)) and will positively influence productivity by complementing the workforce ([Dogru et al., 2023](#)), whereas some other studies suggest it may adversely impact employment ([Gursoy et al., 2022](#)). The literature also highlights that the use of AI in the tourism and hospitality sector is expected to increase, resulting in a growing reliance on AI technology within the sector ([Dogru et al., 2024](#)). Hence, scholars have developed models and frameworks for stakeholders in these sectors in recent years (see e.g., [Bakir et al., 2025](#); [Bilgihan et al., 2024](#); [Dogru et al., 2023](#)). On the other hand, despite the recent development of numerous statistical and econometric methodologies grounded in AI, researchers in the tourism and hospitality sector have not utilized these methods extensively. Consequently, these researchers have concentrated on the application of AI technologies in hotels, shopping malls, restaurants, and retail establishments, as well as on optimizing their efficiency.

This study analyzed the relationship between the tourism and hospitality sector and AI from an alternative perspective in light of the lacuna in the literature. Accordingly, this paper examined the resilience of the tourism and hospitality sector and the overall economy to shocks for 10 major tourism destinations with data for the period 1995-2022 through advanced time series techniques. In addition to unit root tests adopting different approximations to model structural breaks, this paper also employed the AI-based ARNN-ADF unit root test, which is considered to provide more efficient results than traditional unit root tests. Thus, this study sought to furnish policymakers, service providers, and other stakeholders with evidence regarding the transient or enduring impacts of internal and external shocks on the tourism and hospitality sector. The results of the ARNN-ADF unit root test indicate that the impacts of shocks to tourism receipts are temporary in Italy, Japan, and Mexico, whereas the effects of shocks to GDP are transient in Australia, Poland, and Switzerland.

This disparity in the effects of the shocks to tourism receipts highlights the differences and fragility in the recovery dynamics of the tourism sector across countries. While rapid recovery capacity, effective crisis management, and market diversification strategies are prominent in countries where shocks are temporary, the permanent effects in other countries reveal structural weaknesses in their tourism sectors. Developing resilience and diversification strategies and balancing the impacts of shocks by accessing new source markets ([Tan and Tan, 2014](#)) are therefore crucial. Furthermore, strengthening crisis management capacity, implementing early warning systems, and introducing financial support mechanisms play a critical role in reducing the permanent effects of shocks ([Kocak et al., 2023b](#)). Emphasizing sustainable tourism policies and focusing on environmental sustainability and green tourism projects can also help mitigate the

effects of such shocks (Rahman et al., 2024). Adapting the resilience-focused policies of countries like Italy, Japan, and Mexico to other nations can enhance the long-term resilience of the tourism sector. These findings underline the necessity of policies aimed at increasing the sector's resilience to shocks and emphasize the importance of adopting a sustainable and diversified tourism approach.

The study's findings also indicate that only GDP of Australia, Poland, and Switzerland returns to the average. Consequently, the policies enacted in these nations cannot directly influence their long-term growth rates. In these nations, active economic policies are required solely during an economic crisis. Policies enacted in the remaining seven countries may directly influence long-term growth rates. Given only Mexico qualifies as a middle-income country and the others are classified as high-income countries (World Bank, 2024b), it is crucial to implement policies aimed at enhancing potential GDP and long-term growth rates, particularly in Mexico. Considering that the determinants of economic growth include productivity enhancement, human capital development, and technology advancement (see e.g., Barro and Sala-i-Martin, 2004; Acemoglu, 2009, among others), policymakers in Mexico must enhance human capital and augment R&D investments to foster technological progress. Certainly, as a primary goal of economic policymakers is to enhance the long-term growth rate, other nations might similarly elevate their economic growth rates by proactive strategies focused on human capital and technological advancement.

Future research should focus on comprehensive analyses aimed at enhancing tourism's resilience to shocks. In this regard, future studies may examine the impacts of shocks in tourism receipts utilizing various machine learning models through the cross-validation technique. Evaluating the effects of shocks in the tourism and hospitality sector via an AI-based methodology will assist policymakers in formulating strategies for this sector and enable service providers to optimize service supply, as this approach yields more dependable outcomes than conventional techniques. Furthermore, out-of-sample predictions can be employed to forecast tourism receipts considering tourism is a vital catalyst for economic growth. Comparative studies at regional and national levels could investigate the resilience of tourism sectors across varying levels of development. The roles of digitalization, technological innovation, and sustainability practices in recovery from shocks should be explored. Additionally, the long-term impacts of climate change and environmental shocks on tourism, along with strategies to mitigate these risks, warrant further investigation. Dynamic modeling approaches can assess the long-term effects of tourism shocks on economic growth and identify factors that sustain tourism's economic contributions. Finally, the effectiveness of policy and management strategies should be evaluated, with successful case studies providing innovative solutions to strengthen sectoral resilience.

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## Data Availability Statement

The data are available from the corresponding author upon request.

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