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EARTHQUAKE, AIR QUALITY AND TOURISM: EMPIRICAL ANALYSIS FOR TÜRKIYE

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Abstract

Natural disasters can lead to the destruction of tourist attractions and adversely affect the tourism sector. On the other hand, tourism activities are one of the main drivers of disaster recovery. There are also opinions that the deterioration of air quality due to natural disasters hurts the tourism sector. In this context, the study aims to analyse the impact of earthquake events and air quality on tourism activities for Türkiye during 2018-2021 based on provincial data using spatial panel data techniques. The results show evidence of spatial effects. The results indicate the positive and negative spillover effects of real GDP per capita and earthquake occurrences, respectively. Air quality improvements are only shown to increase the number of nights spent abroad, which is statistically significant.

Keywords: Earthquake, Air Quality, Tourism, Türkiye.

JEL Classification: C50, Q53, Z30.

DEPREM, HAVA KALİTESİ VE TURİZM: TÜRKİYE İÇİN AMPİRİK BİR ANALİZ

Özet

Doğal afetler, turistik cazibeyi ve dolayısıyla, turizm sektörünü olumsuz etkilemektedir. Diğer açıdan ise, doğal afet sonrası toparlanmaya katkı sunabilecek başlıca aktivitelerin arasında turizm önde gelmektedir. Bunun dışında, doğal afetler sonucu ortaya çıkan hava kalitesindeki bozulmanın turizme olumsuz etkilerinin bulunduğu da tartışılmaktadır. Bu çerçevede çalışma, deprem ve hava kalitesinin turizm üzerine etkilerini Türkiye için 2018-2021 döneminde iller bazında verilere dayanarak ve mekânsal panel veri tekniklerini kullanarak analiz etmeyi amaçlamaktadır. Bulgular, mekânsal etkilere dair kanıtlar ortaya koymaktadır. Sonuçlar, kişi başına GSYH ve depremlerin sırasıyla pozitif ve negatif yayılım etkilerinin bulunduğu göstermektedir. Hava kalitesinin iyileştirilmesinin ise, sadece yabancı geceleme sayısını istatistiksel olarak anlamlı arttırdığı gösterilmiştir.

Anahtar Kelimeler: Deprem, Hava Kalitesi, Turizm, Türkiye.

JEL Sınıflaması: C50, Q53, Z30.

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1. Introduction

The tourism sector, which is characterised as a smokestack industry, has a positive impact on countries' economic growth, employment and meeting financial needs through foreign exchange inflows. The contribution of global tourism to the world economy is increasing. In 2020, global tourism was disrupted by the pandemic. However, it is undeniable that the tourism sector is one of the key sectors contributing to the recovery of countries in times of crisis. It has been found that countries with high tourism potential recover faster in times of crisis (including pandemics) than countries with a low share of tourism revenues in GDP (United Nations World Tourism Organisation (UNWTO), 2023). After 2019, which was a record year for global tourism, and 2020 and 2021, when the worst days of the pandemic were experienced, Turkey became one of the fastest recovering countries. With significant increases in both total revenue and per capita income compared to 2019, Türkiye overtook France, the country with the highest number of tourists in the world, in terms of per capita income. In 2022, Turkey ranked fourth in terms of the number of tourists, behind France, Spain and the US, and seventh in terms of total revenue, at $41.4 billion. In addition, Turkey's per capita tourist income was recorded at $820 in 2022. This figure surpasses France, which has a per capita tourism income of $752 (UNWTO, 2022).

However, the tourism sector, which has a positive impact on a country's economic growth and enables rapid recovery in times of crisis, is vulnerable to natural disasters. Attractive natural attractions are often vulnerable to climate crises, earthquakes, volcanic eruptions, storms and extreme waves at sea (Beirman et. al, 2018). However, earthquakes can damage the tourism sector by destroying all destinations, including tourist attractions and accommodation facilities. Planning to eliminate these negative impacts is important due to the economic benefits of tourism activities as a driver for short and long-term recovery (Chan et. al, 2020).

The intensity and duration of the news about the earthquake in the public after the earthquake has a negative impact on tourism revenues. It is inevitable that these news reports will lead to a decrease in the number of tourists and tourism revenues, as they increase the anxiety level of tourists and create fear. In this context, uncertainty and fear are crucial psychological dimensions that influence tourist behaviour. According to decision theory in tourism, potential tourists perceive earthquakes as sources of risk and ambiguity, leading to behavioural inhibitions such as destination avoidance and travel postponement (Kozak et al., 2007; Bae & Chang, 2021). Anxiety caused by natural disasters not only reduces travel intentions, but also increases perceived vulnerability, which is a key factor in destination choice.

Furthermore, both traditional and social media serve as important amplifiers of risk perceptions. Studies have shown that constant media exposure to disaster-related content leads to heightened emotional responses, including fear and panic, which directly affect tourism demand (Schroeder & Pennington-Gray, 2015). Social media, in particular, has a viral effect in disseminating visuals and accounts of destruction, further reinforcing travellers' avoidance behaviours. However, when used strategically, media tools can also be used to rebuild the image of a destination and build resilience in tourism recovery after a disaster (Sigala, 2011).

However, the promotional and marketing activities carried out after the earthquake as a result of public-private cooperation have been found to be effective in preventing this negative impact (Beirman et al., 2018). In some cases, an increase in the number of tourists is observed after the earthquake. This is referred to in the literature as a blessing in disguise (Huang et al., 2020). The fact that tourists want to establish an emotional connection with the previously visited destination and want to support it can be effective in realising the phenomenon defined as a blessing in disguise (Karadeniz, 2023).

In addition to the negative impact on tourism, earthquakes can cause air pollution in the regions where they occur. The removal of debris and rubble after earthquakes causes environmental damage. A common view in the literature is that the negative effects of earthquakes on air pollution are due to the release of hazardous substances such as asbestos, lead and other toxins from damaged structures after the earthquake. There is also a view that monitoring the gases that cause this pollution may be a method that can be used to predict earthquakes (Alver Şahin & Kaynak, 2024; Hsu et al., 2010; Zanoletti & Bontempi, 2024).

In this context, this study aims to analyse the impact of earthquake occurrence and air quality on tourism activities in Türkiye between 2018 and 2021 based on provincial data using spatial panel data techniques. Çetin et al., (2022) highlight the importance of spatial clusters of tourism activities and spatial spillover effects of tourism activities and other numerous factors on tourism development. Moreover, ignoring such spatial effects leads to methodologically biased estimates. There are various studies using spatial data analysis in the field of tourism as discussed by Çetin et al. (2022). For example, Karagöz et al. (2022)

recently analysed the relationship between tourism attractions and tourist flows for Türkiye using spatial data analysis. This study also discusses the importance of spatial effects in their analysis. They show evidence of spatial clustering, positive effects of historical and natural attractions and negative effects of cultural attractions on tourist flows. A detailed literature review can be found in Çetin et al., (2022) and Karagöz et al. (2022). However, for Turkey, to the authors' knowledge, no studies have analysed the impact of earthquakes and air quality on tourist arrivals and overnight stays at the provincial level using spatial panel data analysis. Therefore, this study aims to contribute to the existing literature by conducting such an analysis. The results show evidence of spatial effects. The results show that improvements in air quality and economic growth in neighbouring provinces increase provincial tourism activity, while earthquakes in neighbouring provinces decrease it. The next section of the study presents the literature, followed by the methodology and the results of the analysis. Finally, conclusions and evaluations are discussed.

Review of Literature

The tourism sector, a key contributor to the economic growth of many nations, is often significantly impacted by natural disasters, particularly earthquakes. This vulnerability stems from the destruction of essential tourism infrastructure such as historic landmarks, cultural sites, and natural attractions. The aftermath of these disasters can result in sharp declines in tourist arrivals, as observed by Wu & Hayashi (2014), who highlighted that in Japan, natural disasters lead to a more severe reduction in tourism than other disruptive events, such as terrorist attacks or economic crises. Similarly, Göçen et al. (2011) found that while economic crises may not heavily impact tourism in Turkey, natural disasters and epidemics lead to substantial declines in tourist activity.

The devastating effects of earthquakes on tourism have been widely documented. Mazzocchi & Montini (2001) and Henderson (2013) observed that earthquakes in Italy and Japan respectively led to immediate drops in tourism demand. The 2017 earthquake in China, as discussed by Zhang et al. (2021), caused significant destruction to tourism-related infrastructure, further underscoring the vulnerability of tourism in disaster-prone regions. In Turkey, Kodal (2024) confirmed that the tourism sector in Adıyaman was severely affected by the destructive forces of the earthquake, corroborating earlier findings by Kara & Sezgin (2023), who noted that the negative externalities of earthquakes on tourism are often greater than those seen in other sectors.

However, there are instances where post-earthquake recovery results in a surge in tourism. For example, Min et al. (2020) and Huang et al. (2020) demonstrated that regions affected by earthquakes sometimes experience an increase in tourist numbers, a phenomenon attributed to "dark tourism" or the reframing of disaster sites as tourist attractions. This suggests that the impact of an earthquake on tourism is not always purely negative and can vary depending on the nature of the disaster and subsequent recovery efforts.

The role of tourism in post-disaster recovery has been explored in recent studies that emphasize the sector's potential to contribute positively to economic recovery. For instance, Prayag et al. (2019) analyzed the economic impact of tourism expenditures following the 2010 and 2011 earthquakes in Christchurch, New Zealand, using VAR models, finding that tourism significantly boosted local economic recovery. Biggs et al. (2012) explored how tourism resilience in Phuket, Thailand, helped businesses recover after disasters, highlighting the critical need for preparation and adaptive strategies. Becken (2013) further emphasized the importance of assessing tourism resilience across various subsectors to better understand recovery patterns.

In terms of disaster preparedness, Ritchie (2008) argued that comprehensive disaster planning, which includes recovery and mitigation strategies, is essential for reducing the long-term economic impact of natural disasters on the tourism industry. Prideaux et al. (2007) noted that forecasting recovery in disaster-affected regions is complicated due to the overlapping nature of crises, a point particularly relevant for areas like Türkiye.

Another important aspect is the environmental impact of earthquakes, particularly with regard to air quality. Gotoh et al. (2002) found that the 1995 earthquake in Japan led to significant increases in air pollution, largely due to the dust and debris from collapsed buildings. Similarly, Yüksel Yavuz et al. (2024) and Adıgüzel (2023) observed a rise in particulate matter and air pollutants following the Kahramanmaraş earthquakes in 2023, which contributed to severe public health challenges. The relationship between earthquakes and air quality is not entirely negative, however. Uprety et al. (2019) suggested that, over the long term, earthquake-induced destruction could lead to improvements in air quality, as in the case of Nepal, where certain polluting industries were disrupted by the 2015 earthquake. Zanoletti & Bontempi (2024) and Sabırsız & Şöhret (2024) highlighted the need for air quality monitoring systems in earthquake-prone regions to minimize the environmental risks associated with seismic events. Furthermore, Hsu et al. (2010) and Alver Şahin & Kaynak (2024) pointed out that gases such as sulfur dioxide (SO_2) and carbon monoxide (CO) can serve as indicators for earthquake prediction, potentially enabling preemptive actions to mitigate the environmental impact.

Overall, while the literature acknowledges the significant negative impacts of earthquakes on tourism and air quality, it also emphasizes the resilience of these sectors in the face of disasters. The recovery of tourism is influenced by several factors, including government policies, marketing strategies, and the ability of the local population to adapt to changing conditions. Studies like those of Becken (2013) and Ritchie (2008) underline the necessity of integrating disaster preparedness into tourism planning, while others such as Cahyanto et al. (2016) emphasize the role of psychological factors and risk perceptions in shaping tourism demand post-disaster.

Finally, a significant gap in the literature remains regarding the spatial dynamics of these phenomena. This study aims to fill this gap by utilizing spatial panel data techniques to examine the spatial relationships between earthquakes, air quality, and tourism recovery. By addressing these interconnections, the study provides a more nuanced understanding of how natural disasters influence both environmental and economic outcomes in disaster-prone regions

2. Methodology

In order to analyze the effects of earthquakes and air quality on tourism, this study employs spatial panel data techniques. Gani & Clemes (2017) classify the factors which affect tourist arrivals into three groups as demand factors (source country's income level, exchange rates and relative prices), destination characteristics (safety level, pollution, quality of natural environment and governance), and external shocks (natural disasters, wars, economic and political instabilities). Based on destination characteristics and external shocks, the study uses Spatial Durbin Panel Data Model in Equation (1) which also considers endogenous and exogenous spatial interactions, province specific fixed effects (μ_i) and time effects (τ_t).

$$ltourism_{i,t} = \rho W ltourism_{i,t} + \boldsymbol{\beta}_1 lairquality_{i,t} + \boldsymbol{\beta}_2 trade_{i,t} + \boldsymbol{\beta}_3 lgdppc_{i,t} + \boldsymbol{\beta}_4 earthquake_{i,t} + \lambda_1 W lairquality_{i,t} + \lambda_2 W trade_{i,t} + \lambda_3 W lgdppc_{i,t} + \lambda_4 W earthquake_{i,t} + \mu_i + \tau_t + \boldsymbol{u}_{\boldsymbol{i,t}} \quad (1)$$

Where, $\boldsymbol{u}_{i,t} \sim iidN(0,\sigma^2)$ shows the error term for each province i=1, …,81 and year t=2018, ...,2021. μ_i, τ_t, ρ and W represents province specific unobservable fixed effects including preferences and habits, time effects, spatial lag coefficient and 81×81 time-invariant spatial weight matrices generated by considering distances between provinces, border contiguity, and the 2, 3, and 4 nearest neighbors, respectively. While statistically significant spatial lag coefficient shows dependence of province i's tourism activity on province j's, exogenous interaction effects are added in order to measure the dependence of province i's tourism activity on province j's other independent variables, such as province j's air quality, trade openness, real GDP per capita, and occurrence of an earthquake.

In equation (1), the determinants of the tourism activity for each province i and year t ($ltourism_{i,t}$) are taken as air quality ($lairquality_{i,t}$), trade openness ($trade_{i,t}$), real GDP per capita ($lgdppc_{i,t}$), and a dummy variable related to the occurrence of earthquake ($earthquake_{i,t}$). $earthquake_{i,t}$ takes the value of 1 if there occurred a devastating earthquake in province i at time t, and 0, otherwise. Four different measurements were used for tourism activity: total nights spent ($ltotalnights$), foreign nights spent ($lforeignnights$), total tourist arrivals ($ltotalarrivals$), and foreign tourist arrivals ($lforeignarrivals$). Tourists may give their travel decisions based on province i's development level, environmental quality, trade openness, and occurrence of an earthquake. One may expect favorable impacts of development level and trade openness because these may indicate the easy access to various services such as transportation. Moreover, as trade openness show greater global interactions, tourist attractiveness may increase due to higher international trade relationships. Low environmental quality and occurrence of a devastating earthquake may decrease the attractiveness of the destination and affect tourism activities, adversely.

The estimation of the model in equation (1) can be performed by Maximum Likelihood estimation method. In order to select the best fitted model among the ones used in the literature, hypotheses tests are performed shown in equations (2) and (3). If one cannot reject H_{SL}, then, spatial Durbin model reduces to spatial lag model. Spatial error model can be employed if H_{SE} is valid.

$$H_{SL}: \lambda_k = 0, \text{ for all k=1,2, ... ,4} \quad (2)$$

$$H_{SE}: \lambda_k + \rho \times \beta_k = 0, \text{ for all k=1,2, ... ,4} \quad (3)$$

For detailed information related to the method, one can refer to Anselin (1988), Anselin and Griffith (1988), Anselin, Bera, Florax, and Yoon (1996), and Elhorst (2014).

3. Data

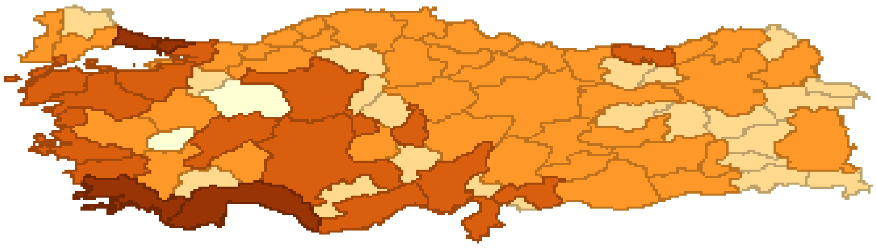
The dataset includes total nights spent, total arrivals, foreign nights spent, foreign arrivals, trade openness (imports plus exports as a percentage of GDP, %), real GDP per capita (base year=2009, TL), and air quality measured by PM10 particulate matter concentration over 2018-2021. Because of availability of data, all the data cover 79 provinces except total and foreign arrivals in which province number reduced to 55. Information and data related to the occurrence of devastating earthquakes and PM10 particulate matter concentration were taken from the report published by Türkiye Republic Presidency Head of Strategy and Budget and from air quality bulletins of Environment and Urbanization Ministry (www.ced.csb.gov.tr), respectively. All the remaining data were obtained from the database of Türkiye's Statistical Institute (TURKSTAT) (data.tuik.gov.tr). The panel series were transformed using natural logarithm. Table 1 gives the summary statistics.

Table 1: Summary Statistics

Variables	Mean	Standard Deviation	Minimum	Maximum	Observations
$ltotalnights$	13.09852	1.353846	10.1091	18.3601	316
$lforeignnights$	10.18107	2.435737	3.52636	18.2295	316
$ltotalarrivals$	10.2965	2.839683	1.1	16.93	220
$lforeignarrivals$	9.165182	3.610208	0	16.52	220
$lairquality$	3.823737	0.34351	2.56495	4.91998	316
$trade$	20.84447	25.1444	0.017755	124.388	316
$lgdppc$	10.65242	0.412574	9.5518	11.9393	316
$earthquake$	0.006329	0.079429	0	1	316

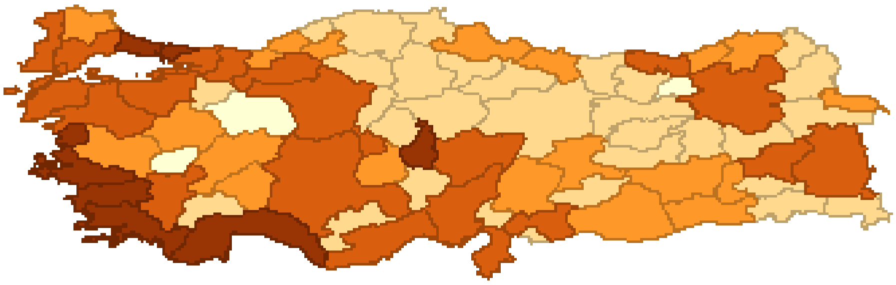
Figure 1, Figure 2, Figure 3, and Figure 4 demonstrate provincial differences in average total nights spent, foreign nights spent, total tourist arrivals, and foreign tourist arrivals. Darker colors show higher values. The highest tourism activities are recorded in Istanbul and Mediterranean region of Türkiye. Moreover, neighboring provinces have similar levels of tourism activities showing the presence of spatial interdependency across provinces.

Figure 1: Total Nights Spent



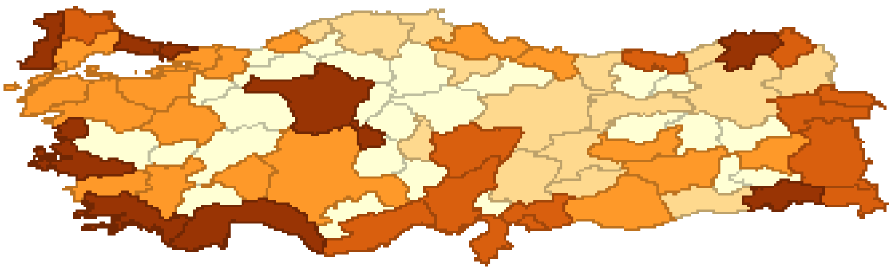
Source: Own construction based on data obtained from TURKSTAT using Geoda

Figure 2: Foreign Nights Spent



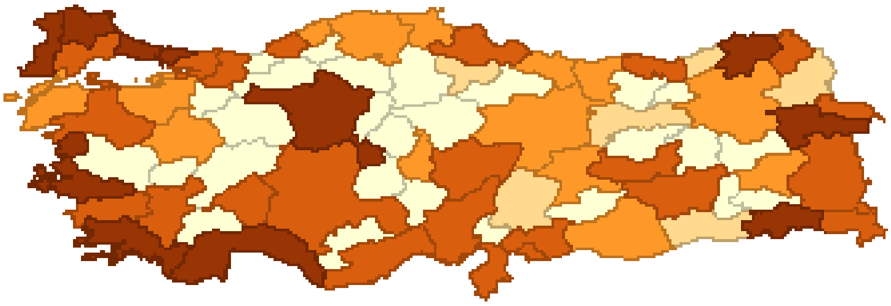
Source: Own construction based on data obtained from TURKSTAT using Geoda

Figure 3: Total Tourist Arrivals



Source: Own construction based on data obtained from TURKSTAT using Geoda

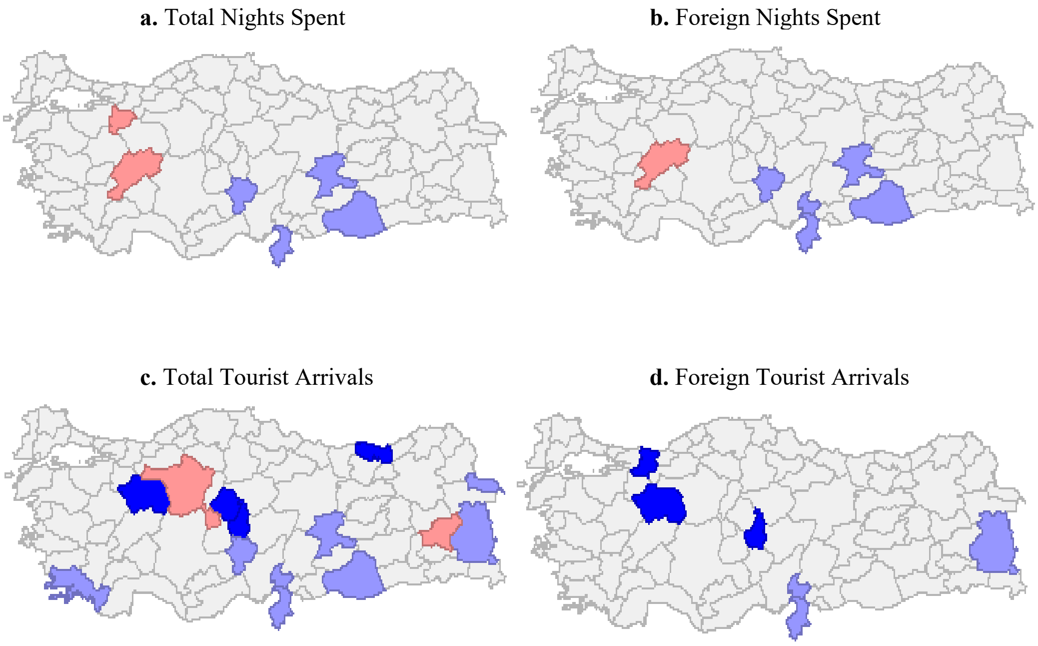
Figure 4: Foreign Tourist Arrivals



Source: Own construction based on data obtained from TURKSTAT using Geoda

Figure 5 illustrates local indicators of spatial analysis (LISA) cluster maps for average total nights spent, foreign nights spent, total tourist arrivals, and foreign tourist arrivals. Dark blue color (low-low) indicate provinces with lower values surrounded by neighboring provinces with lower values. Light-blue color (low-high) show provinces with lower values surrounded by neighboring provinces with higher values. Light-red color (high-low) represent provinces with higher values surrounded by neighboring provinces with lower values. For example, Bilecik and Afyon are cities with higher total nights spent having neighbors with lower total nights. Niğde, Hatay, Malatya, and Şanlıurfa have lower total night spent surrounded by neighbors with higher total nights. Table 2 shows the provinces in each cluster. Çetin et al. (2022) also show that low-low clusters are in Central Anatolia.

Figure 5: LISA Cluster Maps



a. Total Nights Spent

b. Foreign Nights Spent

c. Total Tourist Arrivals

d. Foreign Tourist Arrivals

Source: Own construction based on data obtained from TURKSTAT using Geoda

Table 2: Clusters based on LISA

Clusters	High-Low	Low-High	Low-Low
$ltotalnights$	Bilecik, Afyon	Niğde, Hatay, Malatya, Şanlıurfa	
$lforeignnights$	Afyon	Osmaniye, Niğde, Hatay, Malatya, Şanlıurfa	
$ltotalarrivals$	Ankara, Bitlis	Osmaniye, Niğde, Hatay, Malatya, Şanlıurfa, Muğla, Iğdır, Van	Eskişehir, Kırşehir, Nevşehir, Trabzon
$lforeignarrivals$		Van, Osmaniye, Hatay	Sakarya, Eskişehir, Nevşehir

4. Results and Discussions

Table 3 gives the results of the fixed effects (FE), time period effects (TE), and spatial effects (LM and robust LM tests) tests for weight matrices associated with the highest log-likelihood value which considers the nearest 2 provinces, distances between provinces, and the nearest 3 provinces, respectively. The results indicate evidence of province heterogeneity, time effects and spatial effects.

Table 3: LM tests for Spatial Lag (SL) and Error (SE) Models[a]

Tests	$ltotalnights$	$lforeignnights$	$ltotalarrivals$	$lforeignarrivals$
LM- SL	1.7648 [0.184]	9.4025*** [0.00200]	0.0425 [0.837]	3.2777* [0.07]
Robust LM-SL	0.6114 [0.434]	0.4669 [0.49400]	0.7709 [0.38]	0.0221 [0.882]
LM-SE	2.3573 [0.125]	8.9711*** [0.00300]	0.0062 [0.937]	3.2586* [0.071]
Robust LM-SE	1.2039 [0.273]	0.0354 [0.85100]	0.7346 [0.391]	0.0030 [0.956]
FE test	1388.13*** [0.000]	1083.52*** [0.000]	626.49*** [0.000]	617.8017*** [0.000]
TE test	297.02*** [0.000]	232.42*** [0.000]	32.83*** [0.000]	25.8575*** [0.000]
FE and TE test	1412.95*** [0.000]	1124.90*** [0.000]	639.14*** [0.000]	628.1472*** [0.000]

Source: Calculations based on by Elhorst's (2014) MATLAB codes.

[a]The statistical significances are shown by *, **, *** at 10%, 5% and 1% levels. p values are in square brackets.

The estimation of Spatial Durbin Panel Data Model in Equation (1) is performed by Maximum Likelihood estimation method and including fixed, time and spatial effects. Except the model which has the dependent variable as foreign nights spent, Spatial Durbin Panel Data is employed based on model selection tests shown in Table 3 and 4.

Table 4: Wald and LR test results for the model selection[a]

Hypothesis		$ltotalnights$	$lforeignnights$	$ltotalarrivals$	$lforeignarrivals$
$H_{SL}: \lambda_k = 0$, for all k=1,2, ...,	Wald tests	9.0537* [0.060]	1.2345 [0.87238]	5.6056 [0.23061]	4.3987 [0.3547]
	LR tests	12.0342** [0.018]	1.7241 [0.78633]	7.8854* [0.09586]	5.9773 [0.20084]
$H_{SE}: \lambda_k + \rho \times \beta_k = 0$, for all k=1,2, ...,	Wald tests	8.6606* [0.070]	1.33265 [0.85581]	5.6992 [0.22276]	4.2120 [0.37808]
	LR tests	11.4553** [0.021]	1.8680 [0.76003]	7.9236* [0.09442]	5.8154 [0.21336]

Source: Calculations based on by Elhorst's (2014) MATLAB codes.

[a]The statistical significances are shown by *, **, *** at 10%, 5% and 1% levels. p values are in square brackets.

Tables 5, 6, and 7 present the overall estimation results without and with spatial effects, and results related to direct, indirect, and total effects, respectively. This result is consistent with the study of Özdemir & Tosun (2023), which shows that low environmental quality significantly reduces the demand for tourism.

Trade openness was found to increase total and foreign tourist arrivals. The findings of this study are consistent with those of Hussain (2023), who found that trade openness significantly increases both total and foreign tourist arrivals. This suggests that as trade barriers are reduced, tourism demand is positively influenced, aligning with the observed positive impact of trade openness on tourism in this study.

Findings show that earthquake occurrences decrease foreign nights spent. In a study conducted by Çiftçi & Bayram (2021), it was determined that there was a decrease of approximately 20% in the number of foreign tourists coming to Türkiye after the Marmara Earthquake of August 17, 1999. In addition, the analysis shows that if the earthquake had not occurred, the number of tourists visiting Türkiye in the following periods would have been approximately 8% higher. These findings reveal that earthquakes have a negative effect on the overnight stay behavior of international tourists.

Real GDP per capita increases total and foreign nights spent. This relationship can be explained by the fact that economic growth increases the capacity of individuals to travel and, accordingly, stimulates the demand for international tourism. In particular, a study conducted in Türkiye found that the increase in real GDP per capita has a positive effect on tourism revenues and the number of overnight stays. These findings show that the increase in real per capita income has a positive effect on both the total and the number of foreign overnight stays (Çiftçi & Bayram, 2021).

Moran's statistics indicate evidence of spatial autocorrelation in error terms for all the models except total nights spent. Total and indirect effects' estimation results indicate adverse effects of earthquake occurrence on total nights spent and total tourist arrivals.

Total nights spent decreases by trade openness considering total and direct effects. Findings indicate that air quality improvements increase only foreign nights spent statistically significantly and directly.

Positive spillover effect of per capita real GDP was shown on foreign tourist arrivals. An increase in the nearest three neighboring provinces' per capita real GDP increases a provinces' foreign tourist arrivals, however, an increase in the neighboring provinces' earthquake occurrences decreases provinces' total nights spent and total tourist arrivals. Increase in neighbors' foreign arrivals and foreign night spent affect province's foreign arrivals and nights spent, favorably. This result is line with the findings of Çetin et al. (2022).

Table 5: Estimation Results without Spatial Effects [a]

Independent/ Dependent (y)	$ltotalnights$	$lforeignnights$	$ltotalarrivals$	$lforeignarrivals$
$lairquality$	-0.0661***	-0.2638**	0.3751***	-0.0703
	(-5.6800)	(-2.1700)	(6.2800)	(-0.5600)
$trade$	-0.0031***	-0.0024	0.0191**	0.0162*
	(-3.2700)	(-0.6600)	(2.0800)	(1.7500)
$lgdppc$	0.7736***	1.1685***	1.3664	-0.1147
	(4.7900)	(5.7100)	(1.5700)	(-0.0900)
$earthquake$	-0.0267	-0.1503*	-0.1630	-0.1471
	(-1.0200)	(-1.6800)	(-1.0200)	(-1.2300)
constant	5.4291***	-0.5807	-5.4353	10.4981
	(3.3000)	(-0.2700)	(-0.6000)	(0.8100)
R^2	0.6165	0.5758	0.2834	0.1582
Moran's Test				
2018	-0.0187 [0.7175]	0.0464*** [0.0004]	-0.0204 [0.9351]	0.0071 [0.2774]
2019	0.0002 [0.4113]	0.0248** [0.0229]	0.0266* [0.0582]	0.0645*** [0.0004]
2020	0.006 [0.2575]	0.0015 [0.3861]	0.0523*** [0.0025]	0.0493*** [0.0043]
2021	-0.02 [0.6401]	0.02** [0.0202]	-0.0479 [0.1678]	0.0088 [0.2112]

Source: Calculations based on xtscc and xtmoran commands of STATA 11.
[a]The statistical significances are shown by *, **, *** at 10%, 5% and 1% levels. t values are in parentheses. t values are based on Driscoll-Kraay standard errors. Results of fixed effects and time effects estimates are available upon request. p values are given in square brackets.

Table 6: Estimation Results with Spatial Effects[a]

Independent/ Dependent (y)	$ltotalnights$	$lforeignnights$	$ltotalarrivals$	$lforeignarrivals$
$lairquality$	-0.0761	-0.24424*	0.22205	-0.253508
	(-1.4833)	(-1.71149)	(0.62364)	(-0.557189)
$trade$	-0.0033*	-0.00248	0.02340	0.015311
	(-1.9102)	(-0.50530)	(1.43091)	(0.732249)
$lgdppc$	0.7737***	1.09603**	0.74762	-1.182606
	(3.6888)	(1.99864)	(0.58773)	(-0.747645)
$earthquake$	-0.0541	-0.11636	-0.26723	-0.059691
	(-0.4350)	(-0.32962)	(-0.43381)	(-0.076894)
$Wlairquality$	0.0307		0.20634	0.021102
	(0.4471)		(0.20658)	(0.026739)
$Wtrade$	-0.0025		-0.02993	-0.026593
	(-1.0486)		(-0.70764)	(-0.779427)
$Wlgdppc$	0.1567		3.18469	4.486358*
	(0.5797)		(1.15341)	(1.745411)
$Wearthquake$	-0.4843***		-5.30620*	-1.407684
	(-2.7237)		(-1.85935)	(-1.074815)
Wy	-0.0703	0.38976***	0.06353	0.167221**
	(-1.1616)	(3.72150)	(0.47478)	(2.071850)
σ^2	0.0223	0.1821	0.5264	0.8607
R^2	0.9909	0.9772	0.9517	0.9511
AIC	-390.9352	276.3479	423.8853	533.7653
BIC	-375.9122	291.3710	437.4598	547.3398
LL	199.46759	-134.17399	-207.94264	-262.88264

Source: Calculations based on by Elhorst's (2014) MATLAB codes.
[a]The statistical significances are shown by *, **, *** at 10%, 5% and 1% levels. t values are in parentheses. The maximum value of log-likelihood is shown by LL.

Table 7: Estimation Results for Direct, Indirect and Total Effects[a]

Variables	Direct	t values	Indirect	t values	Total	t values
ltotalnights						
lairquality	-0.0781	-1.53	0.0352	0.52	-0.0429	-0.59
trade	-0.0032*	-1.77	-0.0021	-0.90	-0.0053*	-1.87
lgdppc	0.778***	3.80	0.0705	0.26	0.8492***	3.45
earthquake	-0.0395	-0.32	-0.4649***	-2.63	-0.5043**	-2.38
lforeignnights						
lairquality	-0.2506*	-1.65	-0.1640	-1.29	-0.4146	-1.56
trade	-0.0026	-0.51	-0.0017	-0.46	-0.0042	-0.50
lgdppc	1.0951**	1.96	0.7111	1.41	1.8062*	1.83
earthquake	-0.1095	-0.30	-0.0705	-0.26	-0.1799	-0.29
ltotalarrivals						
lairquality	0.22333	0.64	0.24251	0.22	0.46585	0.42
trade	0.02297	1.36	-0.03272	-0.71	-0.00975	-0.19
lgdppc	0.76327	0.63	3.61527	1.22	4.37853	1.48
earthquake	-0.30881	-0.51	-5.74680*	-1.84	-6.05560*	-1.81
lforeignarrivals						
lairquality	-0.2188	-0.48	-0.1010	-0.11	-0.3198	-0.30
trade	0.0148	0.68	-0.0289	-0.72	-0.0141	-0.29
lgdppc	-0.9031	-0.58	4.9248*	1.70	4.0218	1.20
earthquake	-0.1190	-0.15	-1.6499	-1.08	-1.7688	-0.93

Source: Calculations based on by Elhorst's (2014) MATLAB codes.
[a]The statistical significances are shown by *, **, *** at 10%, 5% and 1% levels.

5. Conclusions

The prevailing view of the impact of natural disasters on the tourism sector is a pessimistic one. In other words, it is believed that natural disasters have a negative impact on tourism. However, there is also an optimistic view in the literature, related to the phenomena of grief tourism and blessing in disguise. There is also interest in the impact on tourism of air quality, which deteriorates as a result of natural disasters.

The main objective of this study is to investigate the impact of earthquake occurrences and air quality on tourism in Turkey during 2018-2021, using provincial data and spatial panel data methods. The results show the positive spillover effects of real GDP per capita and the negative spillover effects of earthquakes. The results also show that improvements in air quality only increase the number of overnight stays by foreign visitors, which is statistically significant. Therefore, as a policy recommendation, provincial administrative units should give importance to improving air quality, which can enhance the tourism attractiveness of provinces. In addition, tourism regions should prioritise the establishment of green tourism policies and promote eco-friendly travel options such as electric vehicles, bicycle routes and the use of renewable energy to further improve air quality and attract tourists who value sustainable practices.

In addition, disaster-resilient tourism facilities should be built to provide quality services to domestic and foreign visitors. To ensure the long-term stability of tourism, earthquake-resistant infrastructure and emergency preparedness should be a priority in regions with high seismic risk. In addition, a nationwide tourism insurance scheme could help mitigate the immediate financial impact of natural disasters on tourism businesses.

The impact on tourism of the earthquake of 6 February 2023, which affected 11 provinces and has been described as the disaster of the century, is undeniable. However, it is recommended that this disaster, which cannot be included in the analysis due to data limitations in these provinces where demolition work is still ongoing, be taken into account in future studies when data is available. Future research should also consider the role of disaster recovery programmes in stimulating tourism demand after natural disasters, with a particular focus on how reconstruction efforts in affected regions can be used to promote tourism.

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