Chin. Geogra. Sci. 2017 Vol. 27 No. 4 pp. 648–659
doi: 10.1007/s11769-017-0892-8

Springer Science Press
www.springerlink.com/content/1002-0063

Pulling Vs. Pushing: Effect of Climatic Factors on Periodical Fluctuation of Russian and South Korean Tourist Demand in Hainan Island, China

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Abstract: While climate is an important factor attracting tourists to certain destinations, it can also motivate people residing in a country with a harsh climate to move to another location. By applying X-12 decompositions and a panel data regression analysis, this study analyzes the pull and push effects of climatic seasonal factors between destination (Hainan Island, China) and source countries (Russia and South Korea). The findings show that climatic seasonal factors have significant pulling and pushing effects on seasonal patterns of tourism demand, with temperature being the main factor. Furthermore, the number of paid vacation days in the source country affects that country's sensitivity to climatic seasonal factors; countries with a higher numbers of paid vacation days are more sensitive to climatic conditions. Lastly, future global warming may causes the aforementioned pull and push effects to abate, which will have an unavoidable influence on tourism industries.

Keywords: seasonality; climate; tourism demand; Hainan Island, China

Citation: Chen Fan, Liu Jun, Ge Quansheng, 2017. Pulling vs. pushing: effect of climate factors on periodical fluctuation of Russian and South Korean tourist demand in Hainan Island, China. *Chinese Geographical Science*, 27(4): 648–659. doi: 10.1007/s11769-017-0892-8

1 Introduction

Climate change is occurring worldwide, impacting the natural environment, people, and our activities (IPCC, 2014a). Tourism is a highly climate-sensitive economic sector (Bode *et al.*, 2003), which means, tourists' demand patterns and comfort levels change significantly depending on the climatic conditions of the source and destination countries (Gössling and Hall, 2006). This may result from the direct impact of climate change, such as global warming, or as a result of secondary impacts, such as reductions in snow depth or impacts on phenology (Ge *et al.*, 2013; Liu *et al.*, 2016). For some tourism-dependent destinations and communities, a decrease in tourism would have significant financial and, thus, social consequences. Accordingly, climate change is widely recognized as one of the most challenging issues impeding the sustainable development of tourism industries (UNWTO *et al.*, 2008). However, compared to agriculture, which contributes 6.1% of the global GDP (CIA, 2012), relatively few studies have examined the effect of climate change on tourism (9.1% of the global GDP (WTTC, 2012)).

Seasonality is one the most significant features of tourism (Koc and Altinay, 2007), which has been evident to tourism researchers for decades (Baron, 1975;

Received date: 2016-11-26; accepted date: 2017-03-09

Foundation item: Under the auspices of the National Natural Science Foundation of China (No. 41430528, 41671036), Ministry of Education of Humanities, Social Science Project (No. 16YJC790060), Social Science Planning Annual Project of Sichuan, China (No. SC15B046), Soft Science Research Project of Sichuan, China (No. 2015ZR0225), Fundamental Research Funds for the Central Universities (No. skqy201639)

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Koenig and Bischoff, 2004; Amelung *et al.*, 2007). Seasonality is demonstrated in short-term fluctuations in tourism demand and tourist and transportation flows (Butler, 1998), and can result from natural causes and/or institutional causes (Hartmann, 1986). Institutional factors reflect social policies and norms, for example, the golden week in China (Qi and Zhang, 2010). Although seasonal patterns in tourism demand differ among regions for various reasons (Baum and Lundtorp, 2001), a close association with natural factors, such as temperature, precipitation, humidity, and hours of sunshine, is always the most important characteristic of tourism seasonality (Cuccia and Rizzo, 2011). Thus, seasonality has a significant influence on a destination's economy, environment, and society. On the one hand, tourism's seasonal feature can mitigate the pressures on natural, social, and cultural attractions in tourist destinations (Grant *et al.*, 1997); on the other hand, seasonal variations negatively affect the economic, ecological, and socio-cultural aspects of tourism, causing increased personnel and social costs (Baron, 1975). In general, studies on tourism seasonality generally focus on economic factors. Those few that have examined the effects of climate (Goh, 2012) include studies on Australia (Hadwen *et al.*, 2011), the Caribbean (Ridderstaat *et al.*, 2014), and Alaska (Yu *et al.*, 2010).

Studies that assess the impact of climate on tourism demand typically do so using individual perception assessments (Wyss *et al*., 2014) and quantitative models (Goh, 2012). An individual perception assessment, measured using a subjective preference survey, calculates the future risk to climate-sensitive destinations, such as ski resorts (Scott *et al*., 2003; 2007) and coastal resorts. However, despite this method being able to provide a preference for future adaptation management, it is not able to assess the impact of climate change on tourism demand statistically. In general, statistical models of the effect of climate change on tourism demand focus on time series analyses of annual data (Rosselló and Santana-Gallego, 2014; Lorde *et al.*, 2015), making it difficult to use these models in studies on short-term seasonal patterns in tourism demand. Furthermore, monthly analysis models of tourism demand regard climatic variables as an influential aspect of integrated tourism demand models (Lorde *et al.*, 2015), along with other segments, such as the economy, distance, and population. Thus, aggregate effects that include seasonal factors, trends, cycles, and irregular segments may lead to inaccurate conclusions on the effect of climate on seasonal tourism demand patterns (Ridderstaat *et al.*, 2014).

To compensate for the lack of existing research, and to better understand how seasonal climatic factors impact short-term tourism demand patterns in island destinations. Here, we investigate the demand for tourism in Hainan Island, which is representative of China's tropical island tourist destinations, from Russia and South Korea. Based on monthly statistics on the island's tourist arrivals and four climatic factors for the period 2007 to 2015, this study uses a panel regression model to analyze the seasonal factors reflected in these time series, separated using X-12 methods. We consider two effects (i.e., the push effect from Russia and South Korea, and pull effect from Hainan Island) of climatic conditions on seasonal tourism demand. This study makes three contributions to the existing literature. First, the results advance our knowledge of the impacts of climate on tourism. Second, we use appropriate data, individual case studies, and analysis methods, providing a more accurate understanding of the relationship between climate and seasonal tourism demand. Third, the results provide a reference for tourism management institutions of Hainan Island to develop and implement management strategies in response to climate change.

2 Materials and Methods

2.1 Study area

Since the 2010–2020 Hainan International Tourism Island Development Planning Outline was proposed, the island's advantages in terms of unique resources, location, and policies have boosted the development of its tourism industry. From the statistics of the Hainan Tourism Development Commission, 1×10^7 tourists visited Hainan in 2000. This number jumped to 30×10^6 in 2011, generating tourism revenue exceeding 3×10^{10} yuan (RMB), demonstrating a positive development trend in Hainan's tourism industry. Then, statistics on the number of foreigners who stayed in Hainan's tourist hotels over the past nine years (Fig. 1) reveal that Russia, Singapore, the United States, Malaysia, and South Korea are Hainan's main five inbound markets, of which Russia and South Korea are the two largest. In 2007, 600 000 stay-over tourists visited Hainan Island, with Russian and South Korean tourists numbering 170 000 (29%) and 200 000 (33%), respectively. By 2011, the number of Russian stay-over tourists had grown to 220 000, before gradually decreasing to around 37 000 in 2015. South Korean was the biggest inbound tourism market in 2007, but declined to 23 000 in 2009, before staying at around 25 000 between 2009 and 2015. Though the numbers of stay-over tourists from Russia and South Korea have dropped, they are still the two biggest inbound markets for Hainan Island, with 140 000 and 57 000 overnight tourists per year, respectively. In addition, because the climatic conditions in Russia and South Korea are significantly different from those in Hainan, these countries' climates push people to leave the country. Therefore, this study focuses on South Korea and Russia as the main source of Hainan's tourism.

Visitors from Russia and South Korea often stay in Sanya, which is renowned for its tropical climate. Sanya is Hainan's most important tourist destination. In 2015, Sanya City received 3.58×10^7 inbound tourists, accounting for 58.88% of the province's tourists that year. Inbound tourism income in Sanya for that year was 1.70×10^8 USD, accounting for 68.51% of tourism foreign exchange earnings in Hainan. In addition, Sanya has many of the world's top resort hotels, which provide a high level of international service for tourists.

Hainan Island is China's second largest island and famous tropical island resort, with rich and unique tourism resources. It is located in the northern tropics, surrounded by the South China Sea. The spatial distribution of Hainan's average maximum and minimum temperatures is characterized by north-south differences. The average maximum temperature is higher in the north and is lower in the south, whereas the average minimum temperature is higher in the south and is lower in the north. Hainan's main climatic advantage is the winter season, but tourism activities continue throughout the year (Wu and Ge, 2009). Thus, we regard Sanya as the main tourist destination in Hainan, given its high concentration of visitors. The temperature-humidity index (THI) is a climate perception index (Fig. 2) that combines temperature and humidity to reflect the heat exchange between the human body and the surrounding environment (Ma *et al.*, 2010). The THI shows that December to March is the most moderately comfortable and suitable period to visit Sanya. In contrast, from April to October, most parts of Sanya are very hot and humid.

Compared to Hainan Province, Russia and South Korea have extremely uncomfortable climatic conditions, especially during winter. In Russia, the humid continental climate dominates the country, with the exception of the tundra and parts of the extreme southeast. Winter and summer are the only two distinct seasons, with most parts of the country experiencing a short spring and autumn. In addition, the subarctic climate means Siberia and most of Northern European Russia have extremely severe winters. Because of the wide range of geographical conditions in Russia, we narrowed down the research field to one of Hainan's main sources of tourism: Novosibirsk, the administration center of the Siberian Federal District, and the third most populous city in Russia, after Moscow and St. Petersburg. In addition, most Russian visitors to Hainan come from Siberia, the Far East, and Primorsky, with a few coming from European Russia. Most outbound tourists from European Russia (e.g., from Moscow and St. Petersburg) prefer traveling to Mediterranean countries, such as Turkey, Egypt, and Spain (Furmanov *et al.*, 2016). Moreover, direct charter flights have been available

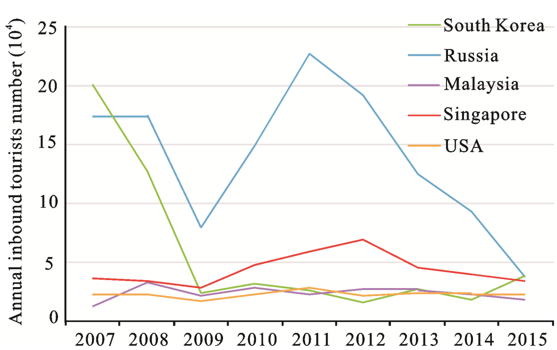

Fig. 1 Number of tourists visiting hotels in Hainan Island per year

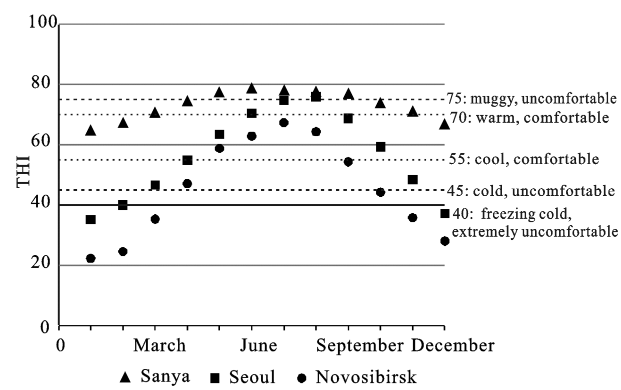

Fig. 2 Temperature-Humidity Index (THI) of Sanya, Seoul and Novosibirsk

from Novosibirsk to Sanya since 2005. With few cities in Russia having direct links to Sanya, this strongly suggests that Novosibirsk is an important tourism market for Hainan. As in the rest of Siberia, Novosibirsk's climate is humid continental, with warm summers and winter temperatures well below freezing. The THIs of Novosibirsk in the five months from November to March are all under 40, indicating that people in Novosibirsk feel extremely cold and uncomfortable during this period.

South Korea, located on the southern half of the Korean Peninsula, has a temperate climate. Compared to Russia's extreme climate, the climate in South Korea is more moderate, with four distinct reasons. The THIs of South Korea are higher than those of Russia for the whole year. However, during three months, from December to February, the THIs fall below 40. These THIs of Russia and South Korea differ markedly to those of Hainan Island in winter. Thus, we assume that the severe climatic conditions in the former countries are crucial push factors causing tourists to leave their homes.

2.2 Data resource

This study uses monthly figures of inbound tourists from South Korea and Russia to Hainan Province for the period January 2007 to December 2015. The data unit is set as person/time. These data were mainly sourced from the statistical data published on Hainan's tourism administrative Web page. We focus on weather data from the meteorological stations in the three countries' major cities relevant to the study, namely Sanya (WMO ID: 59948), Novosibirsk (WMO ID: 29638), and Seoul (WMO ID: 47108), as provided by the meteorological website rp5.ru.

According to Matzarakis (2006), meteorological factors associated with tourism activities include temperature, humidity, wind speed, wind direction, cloud coverage, sunshine duration, rainfall, snow cover, and water temperature. The climate data used in this study include data on monthly average temperatures (℃), relative humidity (%), and cloud coverage (%), and total monthly precipitation (mm). To enhance the stability of the data series, each series is transformed to logarithm form (Table 1).

2.3 Methods

2.3.1 X-12-ARIMA decomposition process

At present, major seasonal adjustment models for economic data are the X-11 model of the Bureau of Census of the United States Department of Commerce, X-11-ARIMA model of Statistics Canada, X-12-ARIMA

Table 1 Statistical description of log time series data

Factor	Variable	Mean	Median	Maximum	Minimum	SD	Coefficient of variation (%)
Pull factors	LTEM_SY	5.693106	5.695078	5.714887	5.670053	0.010882	0.19
	LN_SY	3.975928	3.912023	4.317488	3.218876	0.192317	4.84
	LR_SY	3.829408	4.394144	6.753438	−6.90776	2.063763	53.89
	LU_SY	4.437303	4.477337	4.564348	4.077537	0.110696	2.49
Push factors	*South Korea*						
	LTEM_KR	5.655236	5.660527	5.706612	5.582932	0.035433	0.63
	LN_KR	3.308322	3.218876	4.094345	2.302585	0.462724	13.99
	LR_KR	3.852926	4.067316	6.969415	−6.90776	1.803235	46.80
	LU_KR	4.098184	4.094345	4.369448	3.7612	0.132368	3.23
	Russia						
	LTEM_RU	5.615476	5.6251	5.689176	5.505535	0.050013	0.89
	LN_RU	3.851942	3.912023	4.317488	2.302585	0.318404	8.27
	LR_RU	3.412008	3.465736	5.141664	−0.51083	0.786828	23.06
	LU_RU	4.288442	4.330733	4.465908	3.912023	0.122009	2.85
Tourism demand	LTD_KR	7.876512	7.754649	10.39311	6.196444	0.99731	12.66
	LTD_RU	9.12315	9.224444	10.52586	7.226936	0.676654	7.42

Notes: TEM_SY refers to Sanya's temperature; N_SY, cloud coverage in Sanya; R_SY, rainfall in Sanya; and U_SY, relative humidity in Sanya. TEM_KR refers to Seoul's (South Korea) temperature; N_KR, cloud coverage in Seoul; R_KR, rainfall in Seoul; and U_KR, relative humidity in Seoul. TEM_RU refers to Novosibirsk's (Russia) temperature; N_RU, cloud coverage in Novosibirsk; R_RU, rainfall in Novosibirsk; and U_RU, relative humidity in Novosibirsk. TD_KR refers to Sanya's inbound tourism from South Korea, and TD_RU, that from Russia model of the United States Bureau of Labor Statistics, and TRAMO/SEATS model developed by the Bank of Spain. The most widely employed are the X-12-ARIMA and TRAMO/SEATS models, which were developed in the 1990s and improved upon in the late 20th century. In general, the TRAMO/ SEATS model achieves a better fit when implementing seasonal adjustments to time series for up to 15 years, with many outliers. In contrast, the X-12-ARIMA model often shows optimum results for seasonal adjustments in shorter time series of around four years. Thus, we use the X-12-ARIMA model to analyze our monthly time series data.

Findley *et al*. (1998) developed the X-12-ARIMA seasonal adjustment model, as well as related programs. Using the X-12-ARIMA model, economic time series data Y_t can be separated into trend (T_t), circulation (C_t), seasonal (S_t), and irregular (I) factors. The trend factor (T_t) reflects the long-term trend characteristics in economic time sequence. The circulation factor (C_t) reflects periodic changes in the cycle over several years, including prosperity, economic, or other periodic changes. This factor describes ranges of expansion and contraction in the data in terms of economic issues, as well as data fluctuations over more than one year. Because the circulation factor is difficult to measure in practice, it is normally combined with the trend factor, and called the trend circulation factor (T_C). The seasonal factor (S) describes the periodic, repeatable variation in the sequence. Here, the cycle is 12 months or four quarters, and the vibration and cyclical effects recur in annual cycles. Irregular factors (I) are random events that cause changes such as strikes, accidents, crises, earthquakes, floods, or wars. Seasonal economical series (Y) can be decomposed into two basic forms: an additive or a multiplicative model.

For time series models, the model chosen for analysis is dependent on the relationship between various elements. Consequently, before implementing seasonal adjustments in the time series, the series require a pre-treatment using Equation (1) (Butter and Fase, 1988) to determine the additive or multiplicative decomposition models. If Y_SA is correlated with Y, then the coefficient β is obviously not zero. Hence, the decomposition model should be a multiplicative model. Otherwise, it should be an additive model.

$$\left|Y_t - Y\_SA_t\right| = \alpha + \beta Y\_SA_t + \varepsilon_t \tag{1}$$

where Y is the original time series; Y_SA is the centralized moving average for the year; α and β are coefficients; t denotes time; and ε is the residual.

Using the appropriate decomposition model, the time series is decomposed in order to consider the seasonal factor (SF) on its own (Ridderstaat *et al.*, 2014). Because of the possibility of a unit root within the seasonal factor, a unit root test is implemented on the seasonal factor time series, adopting the method of Im *et al.* (2003). The unit root test results determine whether the time series needs differential processing, as well as the final differential order.

2.3.2 Panel data analysis

After the differential process, the time series are converted into panel data for the regression analysis. This study adopts the pooled mixed regression (OLS) (2), fixed effects (FEM) (3), and random effects models (RAM) (4) to analyze the inbound tourism demand in Hainan from South Korea and Russia, along with Hainan's climatic factors and Russian and South Korean seasonal factors.

$$\begin{aligned} TD\_CO_{i,t} = {} & \alpha_{i,t} + \alpha_2 N\_SY_{i,t} + \alpha_3 R\_SY_{i,t} + \alpha_4 TEM\_SY_{i,t} \\ & + \alpha_5 U\_SY_{i,t} + \alpha_6 N\_CO_{i,t} + \alpha_7 R\_CO_{i,t} \\ & + \alpha_8 TEM\_CO_{i,t} + \alpha_9 U\_CO_{i,t} + \mu_{i,t} \end{aligned} \tag{2}$$

where TD_CO represents the number of tourists to Sanya from South Korea or Russia; N_SY is cloud coverage in Sanya; R_SY is Sanya's rainfall; TEM_SY is Sanya's temperature; U_SY is Sanya's relative humidity; N_CO is South Korea's or Russia's cloud cover; R_CO is South Korea's or Russia's rainfall; TEM_CO is South Korea's or Russia's temperature; and U_CO is South Korea's or Russia's relative humidity. Then, α denotes a coefficients; μ is a residual; i = 1,…, 12; and t = 2007,…, 2015.

$$\begin{aligned} \left(TD\_CO_{i,t} - \overline{TD\_CO_i}\right) = {} & \alpha_2\left(N\_SY_{i,t} - \overline{N\_SY_i}\right) \\ & + \alpha_3\left(R\_SY_{i,t} - \overline{R\_SY_i}\right) \\ & + \alpha_4\left(TEM\_SY_{i,t} - \overline{TEM\_SY_i}\right) \\ & + \alpha_5\left(U\_SY_{i,t} - \overline{U\_SY_i}\right) \\ & + \alpha_6\left(N\_CO_{i,t} - \overline{N\_CO_i}\right) \\ & + \alpha_7\left(R\_CO_{i,t} - \overline{R\_CO_i}\right) \\ & + \alpha_8\left(TEM\_CO_{i,t} - \overline{TEM\_CO_i}\right) \\ & + \alpha_9\left(U\_CO_{i,t} - \overline{U\_CO_i}\right) + \mu_{i,t} \end{aligned} \tag{3}$$

$$TD\_CO_{i,t} = \alpha_{i,t} + \alpha_2 N\_SY_{i,t} + \alpha_3 R\_SY_{i,t} + \alpha_4 TEM\_SY_{i,t} + \alpha_5 U\_SY_{i,t} + \alpha_6 N\_CO_{i,t} + \alpha_7 R\_CO_{i,t} + \alpha_8 TEM\_CO_{i,t} + \alpha_9 U\_CO_{i,t} + \omega_{i,t} \quad (4)$$

where $\omega_{i,t} = \varepsilon_i + \mu_{i,t}$, and ω is an error term.

The *F*-test is applied to determine whether to adopt the FEM or pooled OLS model. The FEM was found to be superior to the pooled OLS model. Further assessment revealed that the FEM was more appropriate than the REM. The Hausman test is used in this study.

To analyze the impacts of holiday length on the seasonality of travel demand, a dummy variable for vacation is added to the analysis (1 = vacation; 0 = non-vacation). Holiday months are selected according to school and published official national holidays in South Korea and Russia. The holiday months in South Korea fall in January, February, May, July, and August, whereas those in Russia are from January to March, May to June, and October to December. The REM (Ridderstaat *et al*., 2014) is used for the panel data regression analysis on the seasonal series data, including the dummy variable, of South Korea and Russia.

Based on the results of the regression, factors are selected that have a significant impact on the seasonal variation in the number of inbound tourists. Distance is calculated using the Euclidean distance measure formula (5) (Kulendran and Dwyer, 2010) to determine the monthly differences between climatic and seasonal tourism demand factors. A smaller EDM indicates a stronger association between these two factors.

$$\text{EDM}_m = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(CS_m - TDS_m\right)^2} \quad (5)$$

where EDM is the Euclidean distance; *CS* is climate series; *TDS* is tourism demand series; *n* is the sample size; and *m* is the month.

3 Results

All estimates were implemented using Eviews version 6 and Excel 2007. The results in Table 1 show that most of the time series are stable after the logarithmic process, which was conducive to further research and analysis. Only the time series of the rainfall variable still contained instability. The results in Table 2 show that most of the time series use the additive model after the X-12 decomposition. However, the circulation, seasonal, and irregular factors are not related to its trend. Only the tourist quantity variable uses a multiplicative model. This variable's trend factor is correlated with other factors because the number of visitors is associated with seasonal changes.

Table 2 Model type selections of log time series

Factor	Variable	Model type selection	
		Coefficient	Model type
Pull factors	LTEM_SY	0.028087	Additive
	LN_SY	0.014737	Additive
	LR_SY	−0.017027	Additive
	LU_SY	0.021142	Additive
Push factors	*South Korea*		
	LTEM_KR	0.195836	Additive
	LN_KR	0.073438	Additive
	LR_KR	−0.034932	Additive
	LU_KR	0.004685	Additive
	Russia		
	LTEM_RU	0.172294	Additive
	LN_RU	0.000934	Additive
	LR_RU	0.002203	Additive
	LU_RU	0.03043	Additive
Tourism demand	LTD_KR	0.043286*	Multiplicative
	LTD_RU	0.043077*	Multiplicative

Notes: * indicates significance at the 10% level. The abbreviation is same with Table 1

After decomposing the time series using the appropriate decomposition model, a unit root test is conducted on the time series of seasonal factor variables (Table 3). Because the temperature variables of the three cities presented a first-order unit root, all variables underwent first-order differential conversion to facilitate the regression analysis of the panel data. After the first-order differential conversion of the time series, all data series are converted to panel data, with each variable composed of 12 units, and each unit covering nine years (2007–2015). We then implemented the panel data analysis.

Table 4 presents the results of the panel data regression analysis. Prior to including the holiday dummy variable, the OSL and REM were used on data from South Korea and Russia, respectively. In the case of South Korea, the OLS F-value is 11.52 (0.00), which is better than the F-value in the FEM of 10.46 (0.00). Hence, the OLS method is selected. For Russia, the

Table 3 Unit root rest results

Variables	*t*-values (intercept only)		*t* -values (intercept and trend)		Degree of integration
	lag = 0	lag = 1	lag = 0	lag = 1	
LTEM_SY	−3.1671**	−9.4465***	−3.1143	−9.3825***	I (1)
LN_SY	−8.2906***	−8.2906***	−8.2541***	−8.2541***	I (0) or I (1)
LR_SY	−4.0147***	−5.7116***	−3.9675**	−5.6588***	I (0) or I (1)
LU_SY	−4.9791***	−6.1343***	−4.9786***	−6.1138***	I (0) or I (1)
LTEM_KR	−2.9016**	−16.98***	−2.8511	−16.878***	I (1)
LN_KR	−6.3477***	−7.5047***	−6.3153***	−7.4673***	I (0) or I (1)
LR_KR	−4.2136***	−5.2981***	−4.1747***	−5.268***	I (0) or I (1)
LU_KR	−4.3217***	−6.1934***	−4.2853***	−6.1663***	I (0) or I (1)
LTD_KR	−6.9968***	−8.9281***	−6.9495***	−8.8789***	I (0) or I (1)
LTEM_RU	−3.1545**	−12.014***	−3.1112	−11.947***	I (1)
LN_RU	−5.5211***	−7.0988***	−5.5142***	−7.0795***	I (0) or I (1)
LR_RU	−5.5762***	−5.5762***	−5.5389***	−5.5389***	I (0) or I (1)
LU_RU	−4.1957***	−7.2132***	−4.1857***	−7.1858***	I (0) or I (1)
LTD_RU	−7.9302***	−7.9302***	−7.8935***	−7.8935***	I (0) or I (1)
Critical values	Intercept		Intercept and trend		
1%	−2.062		−2.662		
5%	−1.906		−2.524		
10%	−1.824		−2.45		

Notes: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. The abbreviation is same with Table 1

Table 4 Panel regression results

	Without holiday dummy (OLS)		With holiday dummy (REM)	
	South Korea	Russia	South Korea	Russia
Intercept	0.000305	0	−0.0008	−0.0005
LTEM_SY	5.458699***	2.351402**	5.982366***	2.344785**
LN_SY	0.147349***	0.070281**	0.117442**	0.072592**
LR_SY	−0.01393***	0.005198**	−0.00362	0.005903**
LU_SY	−0.26918**	−0.18595**	−0.22213**	−0.1929**
LTEM_KR	−4.02062***		−3.93174***	
LN_KR	0.036258**		0.02562*	
LR_KR	0.027492***		0.02016***	
LU_KR	0.159339**		0.224775***	
LTEM_RU		−0.01136		0.007925
LN_RU		−0.04885*		−0.04917*
LR_RU		0.005608		0.005953
LU_RU		−0.08981*		−0.08406
Dummy_KR			0.002608*	
Dummy_RU				0.000612
R^2	0.469851	0.205558	0.423437	0.195885
F-test	11.52438***	4.07259***	8.752177***	3.571363***

Notes: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. The abbreviation is same with Table 1

FEM F-value is 12.41 (0.00), which is better than that of the OLS method, 7.17 (0.00). Moreover, the REM is used for the pool analysis and the Hausman test is implemented. The test value obtained from the Hausman test is 13.26, with *df* of 8, and a *p*-value of 0.1031. As such, the REM is given priority.

Without the holiday dummy variable, the panel regression results show that the pull effects of Hainan's seasonal climatic factors are significantly stronger than the push effects from the source countries. The influence of various seasonal climatic factors differs between the two countries. In the case of South Korea, the seasonal factors of temperature and cloud cover in Hainan show a significant positive impact at the 1% level of significance, whereas rainfall and relative humidity have a negative impact at the 1% and 5% levels of significance, respectively. All seasonal climatic push factors for South Korea have a significant impact on the country's short-term seasonal tourism demand. An increase in the seasonal push factor of temperature in South Korea, largely due to global warming, leads to a decrease in the push effect on seasonal tourism demand. Conversely, the coefficients of rainfall, cloud cover, and relative humidity in South Korea show a positive influence, indicating that short-term increases in these seasonal factors result in an increase in seasonal tourism demand from South Korea.

In Russia, the estimates without the dummy variable reveal that all Hainan's seasonal climatic pull factors are significant at the 5% level. Furthermore, temperature, cloud cover, and rainfall in Hainan have a positive impact on f tourism demand from Russia. However, relative humidity shows a negative influence. Only cloud cover and relative humidity show significant negative impacts on seasonal tourism arrivals from Russia. In other words, short-term increases in cloud cover and relative humidity cause a decrease in seasonal tourism demand from Russia.

Next, we include the holiday dummy variable. The results show that the holiday factor has a significant and positive impact on tourism demand from South Korea, but is not statistically significant in the case of Russia. Thus, the seasonality of vacations and holidays is an influential factor in seasonal tourism demand from South Korea. In addition, temperature, cloud cover, and relative humidity in Hainan are determining factors of seasonal South Korean tourism demand. With regard to the push factors, all four still show, a significant impact on the seasonal patterns of tourism arrivals from South Korea. In the case of Russia, the holiday dummy variable appears not to have a significant influence on seasonal tourism demand. Furthermore, the coefficients of the seasonal pull factors in Hainan show little difference from the results without the dummy variable. The seasonality of cloud cover in Russia is the only seasonal factor affecting tourism demand from this country.

Fig. 3 and Table 5 show the Euclidean distance results of the variables, which demonstrate a significant influence in the regression analysis after the dummy variable is added. Fig. 3 shows that the seasonal fluctuations of monthly tourism demand have different sensitivities to seasonal climatic factors. Table 5 shows the months in which the Euclidean distances are lower than the annual average. These findings show that the seasonal factors of tourism demand have stronger sensitivity to climate variation. In Russia, April, July to August, and November to December are more sensitive to climate variation. In South Korea, this occurs in June to July and in December. For the remaining months, the holiday factor is more influential on travel motivation. The holiday months in South Korea are in line with the test results. The results also match the fact that South Korea has fewer days of paid holidays. The likelihood of outbound travel increases in periods of national holidays.

4 Discussion and Conclusions

This study used monthly data of inbound tourists from South Korea and Russia, which are Hainan's two main tourism markets, as well as monthly data on tourism-related climatic factors. The research period covered 108 months, from 2007 to 2015. Using a novel approach, we extracted seasonal factors from climatic time series and tourism demand series to reveal the relationships between the two. The results of the regression analyses show that climatic conditions in the tourism source regions and in the destination have push effects and pull effects, respectively, in terms of tourists' travel decision-making. These results agree with those of Ridderstaat *et al*. (2014), who investigated the correspondence between seasonal climatic factors and seasonal patterns of tourists from the United States and Venezuela traveling to Aruba.

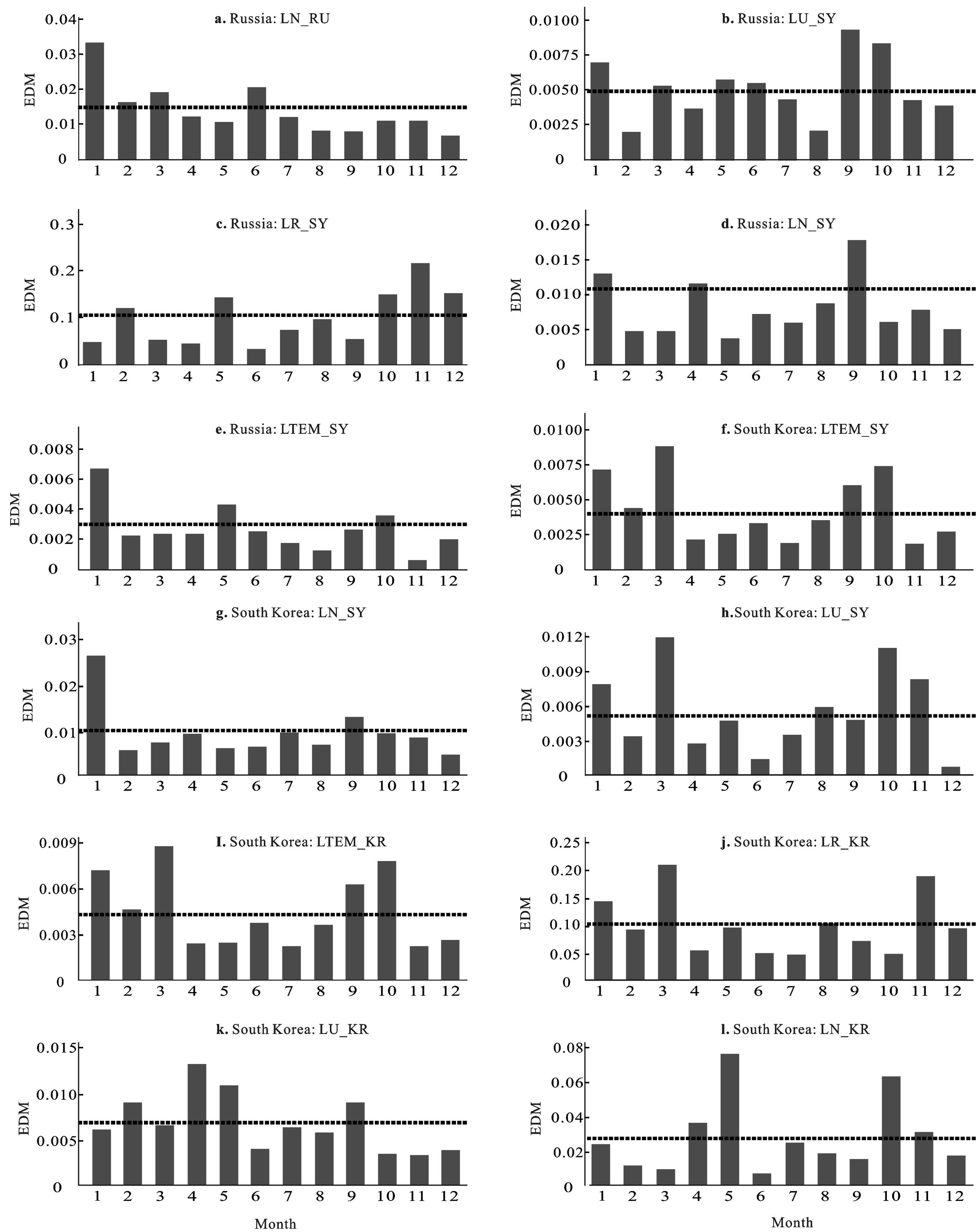

Fig. 3 Euclidean distance Measure (EDM) of weather factors and tourism demand variables. Dotted lines show average values

Table 5 Euclidean distance measure (EDM) results

Month	Russia					South Korea						
	LN_RU	LU_SY	LR_SY	LN_SY	LTEM_SY	LN_KR	LU_KR	LR_KR	LTEM_KR	LU_SY	LN_SY	LTEM_SY
Jan.			○			○	○					
Feb.		○		○	○	○		○		○	○	
Mar.			○	○	○	○	○				○	
Apr.	○	○	○		○			○	○	○	○	○
May	○			○				○	○	○	○	○
Jun.			○	○	○	○	○	○	○	○	○	○
Jul.	○	○	○	○	○	○	○	○	○	○		○
Aug.	○	○	○		○	○	○		○		○	○
Sep.	○		○		○	○		○		○		
Oct.	○			○			○	○			○	
Nov.	○	○		○	○		○		○		○	○
Dec.	○	○		○	○	○	○	○	○	○	○	○

Notes: ○ indicates EDMs below the annual average. The abbreviation is same with Table 1

In addition, this study discussed the reasons for tourists' sensitivity to four climatic factors, namely temperature, precipitation, humidity, and cloud coverage. The specific effects of each seasonal climatic factor differ between Russia, South Korea, Hainan Island, the United States, Venezuela, and Aruba, particularly in terms of temperature, which is a significant pull factor in this study. This is because Hainan Island is a typical tropical destination where tourists from the higher latitude countries tend to try to avoid the severe winters. Russia and South Korea are both located in high latitude regions, and experience extremely cold winters. Thus, escaping from these winters is an important factor driving tourists to other regions. However, Hainan's humidity and rainfall conditions are unfavorable factors for inbound tourism. This result is consistent with those of Rosselló and Santana-Gallego (2014), who find that people living in areas with cold, cloudy, and humid climates tend to visit destinations with a better climate, typically with less rain and higher temperatures. The results for the climate factor of cloud coverage did not have the expected result, which might be because the cloud coverage data included nighttime data, and because the meteorological stations only cover relatively small parts of the overall region. Hence, the data might not reflect the true cloud distributions in the tourist source regions.

Furthermore, having comfortable climate conditions in a travel destination is an important factor attracting tourists. The travel comfort index (TCI) (Mieczkowski, 1985) for Sanya from November to April is always high (Liu *et al.*, 2014). The climate comfort in winter is one of the main attractions for tourists to Sanya. Future climate change scenarios show that Sanya's tourism climate index in January, February, and December will be consistent for the next 50 years, but the index values for March to November will decrease (Liu *et al.*, 2014). Even though the TCI provides a comprehensive climatic reference for tourism destinations, it does have certain deficiencies. The key drawbacks of the TCI include its subjective assessment systems; the omission of critical physical climatic factors, such as rain and wind, and its inability to evaluate the impact on tourism demand using a quantitative analysis (Rosselló, 2014). The average global temperature from 2016 to 2035 is predicted to increase from 0.3℃to 0.7℃(RCPs 4). From 2081 to 2100, the temperature is expected to increase by 1.1℃to 2.6℃(RCP4.5) (IPCC, 2014b). By 2050, South Korea's annual temperature is predicted to increase by between 1.9℃(RCP4.5) and 3.0℃(RCP8.5) (Minor *et al.*, 2016). Global warming trend will weaken the pull effect and the push effect, which means that Hainan's tourism industry will need to adapt accordingly.

Moreover, although climatic factors have a major impact on the number of inbound tourists, seasonal variations are associated with the vacation mode in the source country. The results reveal that, compared to Russian tourists, South Korean tourists are more sensitive to the length of their paid holidays. The numbers of official national holidays in Russia and South Korea are similar. However, because the dates are fixed and short term, they have a limited influence on outbound long-distance travel. In contrast, a paid holiday is a personal choice, and could last longer. The minimum number of days of paid holidays in Russia is 28 days, which ranks fifth in the world. In South Korea, the corresponding value is only 15 days. Countries with longer paid holidays are more sensitive to climatic factors, while in those with shorter paid vacations, seasonal differences are more influenced by national holidays. Therefore, paid holidays have a significant impact on outbound travel from South Korea. This finding has practical significance for tourist destinations for marketing in target tourist countries.

This study has certain limitations. Competition from Southeast Asian coastal countries, such as Vietnam and Thailand, should also be considered when discussing Hainan Island's inbound tourism demand. Russian tourists are sensitive to the price factor, and most stay in the economic holiday resorts on Hainan Island. The inexpensive prices and high quality of service in Southeast Asia mean that the number of charter flights from Russia to southeast countries has been increasing gradually, resulting in a reduction in Hainan Island's tourism market share. This omission is the result of economic factors and, thus, is beyond the scope of this study.

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