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An Investigation into the Impact of Climatic and Economic Variables on Tourism Demand in Japan

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Abstract

The aim of this study is to analyze the influence of climatic and economic variables on Japan's seasonal tourism demand variation. Seasonal tourism fluctuations can present a serious problem, since the profit and daily administration of stakeholders, as well as tourism policy design, are affected.

Considering these aspects, this study investigated the influence of climatic and economic variables on tourism demand fluctuations in typical tourist destinations in western Japan. GMM (Generalized Method of Moments) estimations, based on two models, are implemented in an empirical study. Measurement error and the endogeneity of the variables, as well as the correlation between the explanatory variables and the error term, are considered.

The first model's estimated parameters imply that rainfall is a negative factor in Kyoto's tourism, while temperature and price levels are positive elements. In spite of the presence of these positive factors in Hiroshima, we could not determine the effects of rainfall and vitalization of the regional economy on tourism in this area. In Naha, temperature, price level, and vitalization of the regional economy may increase the number of visitors.

The second model's estimates for Kyoto imply that temperature, sunshine duration, and price level are positive influences. For Osaka, Fukuoka, and Hiroshima, we find that sunshine duration, and price level are positive factors. In Hiroshima, temperature is an additional positive factor, while the effects of vitalization of the regional economy cannot be determined. For Naha, temperature, price level, and vitalization of regional economy may increase the number of visitors, but no conclusion can be drawn about the effect of sunshine duration.

Key words: tourism demand, climatic variable, seasonal fluctuation
JEL Classification: Z32, R58, O18

1. Introduction

This study examines the influence of climatic and economic variables on tourism demand fluctuations in western Japan's typical tourism destinations, namely, Kyoto, Osaka, Hiroshima, Fukuoka, and Naha. Seasonal tourism fluctuation can be a serious problem since it has a certain influence on the profit and daily administration of stakeholders and tourism policy design. GMM (Generalized Method of Moments) estimations are implemented to investigate this problem, considering measurement error and the endogeneity of the variables as well as the correlation between the explanatory variables and the error term.

This paper is organized as follows. Section 2 provides a review of previous studies on the seasonal variation of tourism, while Section 3 describes the seasonality in tourism in Japan. The estimation method is described in Section 4, and Section 5 outlines an empirical analysis to investigate the influence of climatic and economic variables on tourism demand fluctuation in the typical tourist destinations in western Japan by applying GMM (Generalized Method of Moments) estimation. Finally, Section 6 summarizes and concludes the study.

2. Seasonality in Tourism: A Review

Previous studies on seasonal tourism variations mainly describe the technical aspects that are required to accurately comprehend seasonality for tourism demand prediction and to provide policy perspectives. Lundtorp (2001) provides a comprehensive explanation of seasonal tourism variation, and mentions the role of the supply chain and the continuity of transportation in seasonal variations of tourists' destination selections. Butler (2001) reviews the causes and effects of seasonal variations in tourism by pointing out the practical difficulties with regard to measures to mitigate variations. Lundtorp (2001) discusses some approaches to understanding seasonal tourism demand variations, including the use of the seasonal variation index and the Gini coefficient to reflect the size of the annual seasonal variation. To minimize the effects of seasonal variations on tourism, some researchers - including Kulendran and King (1997), Lim and McAleer (2001), and Goh and Law (2002) - estimate tourism demand precisely. By contrast, Koc and Altinay (2007) analyzes the Turkish seasonal tourism variation patterns by taking advantage of the X-12-ARIMA model, and outlines different patterns of visitors, tourism expenditures, and tourism expenditure seasonality.

Nadal *et al*. (2004) consider the relationship between the Gini index and economic variables such as GDP in assessing UK and German tourists who visit the Baleares Islands. They show that an increase in the UK or Germany's GDP, and a rise in the relative price between these two countries and the Baleares Islands, would decrease the Gini index. They also find that economic conditions such as income and relative price, are decisive factors in determining the number of visitors based on gravity theory.

The seasonal tourism fluctuation further depends on the characteristics of the destination. Visitors to nature-oriented destinations such as national parks are more influenced by climatic conditions than those who visit culture-oriented destinations. Morales (2003) analyzes the seasonality of three tourism destinations in Spain (Malaga, Granada, and Armenia), and emphasized the effect of culture-oriented policies such as the construction of an art museum in decreasing the Gini index. Morales (2003) also finds that attractions such as cultural exhibitions and theatre performances are unrelated to tourism seasonality. Cuccia and Rizzo (2011) classify six Sicilian destinations (in Italy) into four clusters according to their cultural attractiveness, showing that seasonality depends on the variety of cultural attractions.

Tourism demand seasonality is rather a supply-side issue; its impact affects tourism management. Decision-making by the managers of accommodation facilities, catering services, attractions, and tour operators is based on investment and fund management, and aims to realize flexible employment, tourism, and a differentiation strategy. In this respect, a policy to mitigate seasonal variation is necessary for stable and profitable management (Lee *et al*. (2008)). However, because some causes of tourism seasonality, which are related to natural- and socio-economic factors, do not correspond with each other, various strategies and individual evaluations should be determined. On the other hand, Kulendran and Dwyer (2010; 2012) focus on economic factors, in addition to climatic elements, when considering the influence of seasonal fluctuations on tourism demand.

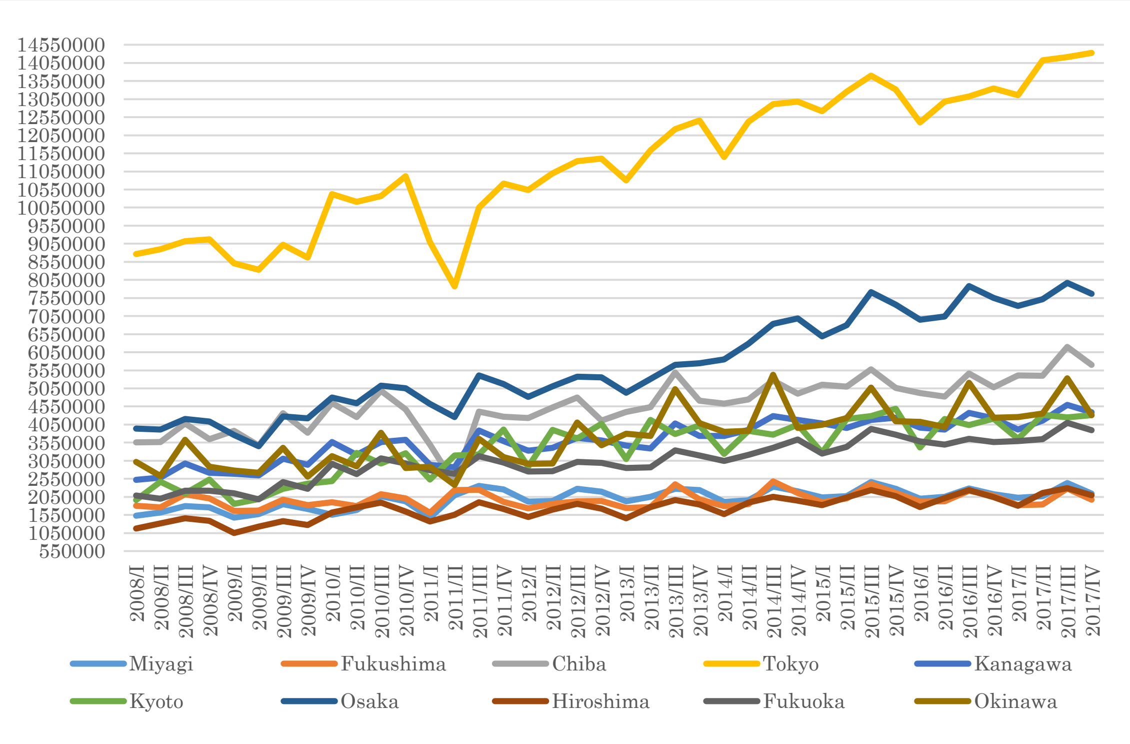
3. Trends in Tourism Seasonality in Japan

In this section, we examine tourism seasonality in the Japanese context. Figure 1(a) shows the quarterly seasonal variation in tourism demand for ten prefectures - Tokyo, Miyagi, Fukushima, Chiba, Kanagawa, Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa. Figure 1(b) displays estimated Gini coefficient on tourism variation. The areas for analysis include prefectures located in eastern Japan, in addition to the ones in western Japan, so as to consider the effect of the Great East Japan Earthquake of March 2011. From Figure 1(a), we derive important information with respect to the seasonal variation in tourism demand. First, seasonal tourism demand fluctuates with a regular form. Second, the Great East Japan Earthquake might not have had a large influence on western Japan. Figure 1(b) indicates that the Gini coefficient for 2011 is exceptionally large compared with the other years. Especially, Miyagi, Fukushima, and Chiba suffered great losses, due to their proximity to the seismic sources of the earthquake.

The Gini coefficients for overseas tourists as well as for all tourists (including both domestic and inbound tourists) can be calculated by using the accommodation data of tourists visiting the ten prefectures listed above. The comparison of Table 1(a) and 1(b) shows that the Gini coefficients for inbound tourists tend to be larger than those for all tourists. This might imply that the seasonal variation of inbound tourists is relatively larger than that of the others.

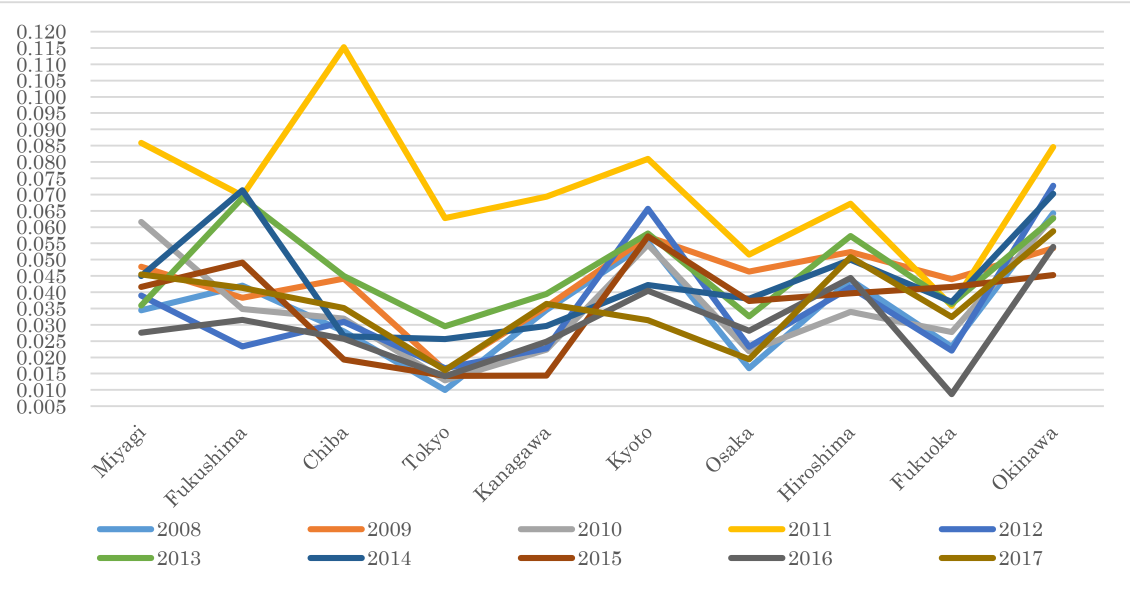
Figure 2(a) shows seasonal variations in guests at accommodation facilities and Figure 2(b) displays the estimated Gini coefficients for the prefectures of Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa.

Figure 1(a): Seasonal Variation in Overnight Guests (Quarterly Basis)



Notes: The data for making this figure was obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/Siryou/toukei/shukuhakutoukei.html)

Figure 1(b): Gini Index at Prefectural Level



Notes: The Gini index is calculated based on the sequence data obtained from this survey. The data for making this index were obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/siryou/toukei/shukuhakutoukei.html)

Table 1(a): Gini Coefficients for Overseas Guests

Gini Index	Miyagi	Fukushima	Chiba	Tokyo	Kanagawa	Kyoto	Osaka	Hiroshima	Fukuoka	Okinawa
2008	0.0785	0.1866	0.1083	0.0948	0.0673	0.0979	0.0611	0.2012	0.1001	0.1479
2009	0.1377	0.4102	0.0529	0.1068	0.0636	0.1055	0.0513	0.1445	0.0894	0.1214
2010	0.1452	0.1471	0.1438	0.1595	0.1822	0.1412	0.1434	0.2504	0.1415	0.1761
2011	0.2429	0.4498	0.0987	0.1738	0.0874	0.1500	0.1332	0.0704	0.1192	0.1314
2012	0.1796	0.4024	0.0559	0.0429	0.0487	0.1244	0.0790	0.1412	0.0503	0.0961
2013	0.1370	0.1903	0.0425	0.0535	0.0760	0.1346	0.0923	0.0806	0.0628	0.1295
2014	0.1677	0.1318	0.0687	0.0653	0.0921	0.1295	0.0814	0.1267	0.0860	0.0978
2015	0.1250	0.3201	0.0689	0.0300	0.0675	0.0843	0.0584	0.1183	0.0666	0.0578
2016	0.1457	0.2265	0.0647	0.0253	0.0342	0.0792	0.0639	0.0991	0.0679	0.0355

Notes: The data for making this table was obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/siryou/toukei/shukuhakutoukei.html)

Table 1(b): Gini Coefficients for Total Guests

Gini Index	Miyagi	Fukushima	Chiba	Tokyo	Kanagawa	Kyoto	Osaka	Hiroshima	Fukuoka	Okinawa
2008	0.0344	0.0420	0.0280	0.0100	0.0346	0.0553	0.0167	0.0438	0.0232	0.0643
2009	0.0478	0.0383	0.0442	0.0161	0.0356	0.0571	0.0463	0.0524	0.0440	0.0535
2010	0.0616	0.0348	0.0319	0.0129	0.0223	0.0546	0.0219	0.0340	0.0278	0.0630
2011	0.0859	0.0697	0.1152	0.0628	0.0694	0.0810	0.0516	0.0672	0.0358	0.0845
2012	0.0390	0.0234	0.0309	0.0167	0.0228	0.0656	0.0232	0.0415	0.0220	0.0727
2013	0.0359	0.0689	0.0450	0.0295	0.0395	0.0581	0.0326	0.0573	0.0365	0.0627
2014	0.0449	0.0713	0.0265	0.0256	0.0296	0.0422	0.0380	0.0499	0.0370	0.0703
2015	0.0417	0.0491	0.0193	0.0143	0.0144	0.0571	0.0373	0.0396	0.0417	0.0452
2016	0.0276	0.0316	0.0257	0.0142	0.0248	0.0404	0.0281	0.0444	0.0087	0.0539

Notes: The data for making this table was obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/siryou/toukei/shukuhakutoukei.html)

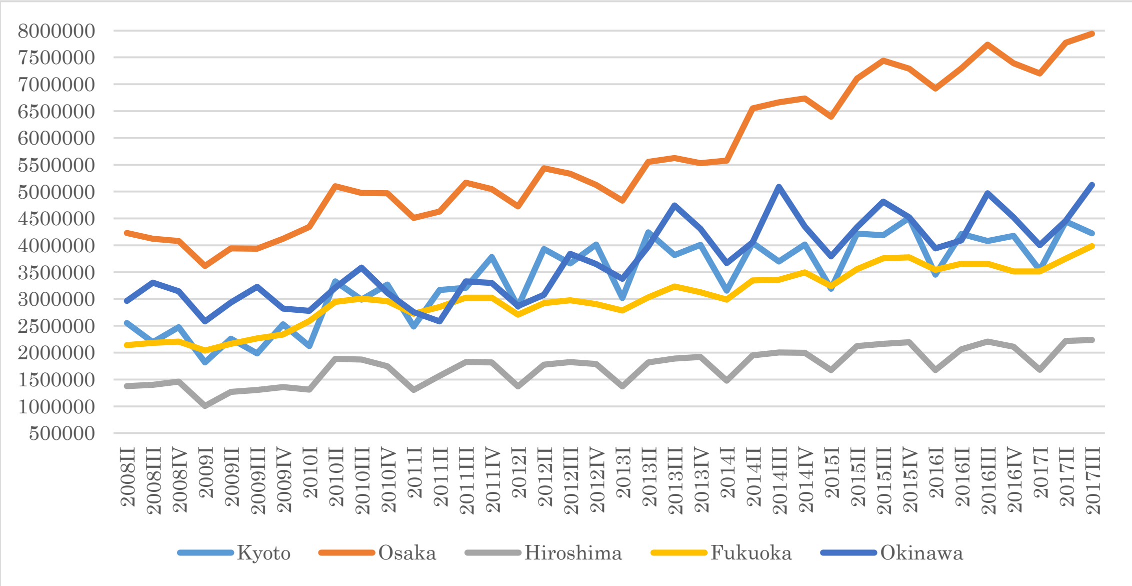
The former implies instability in the seasonal fluctuation of tourism demand, while the latter indicates that Gini coefficients are smaller for Osaka and Fukuoka, but relatively larger for Kyoto, Hiroshima, and Okinawa. In addition, both figures might reflect the impact of the Great East Japan Earthquake of March 2011.

4. Method

This section describes the method used in our empirical analysis of the influence of climatic and economic variables on tourism in several Japanese areas. The sample period of estimation (monthly basis) is 2008:M1 (January) to 2017:M12 (December). Our dataset is composed of the following variables.[1]

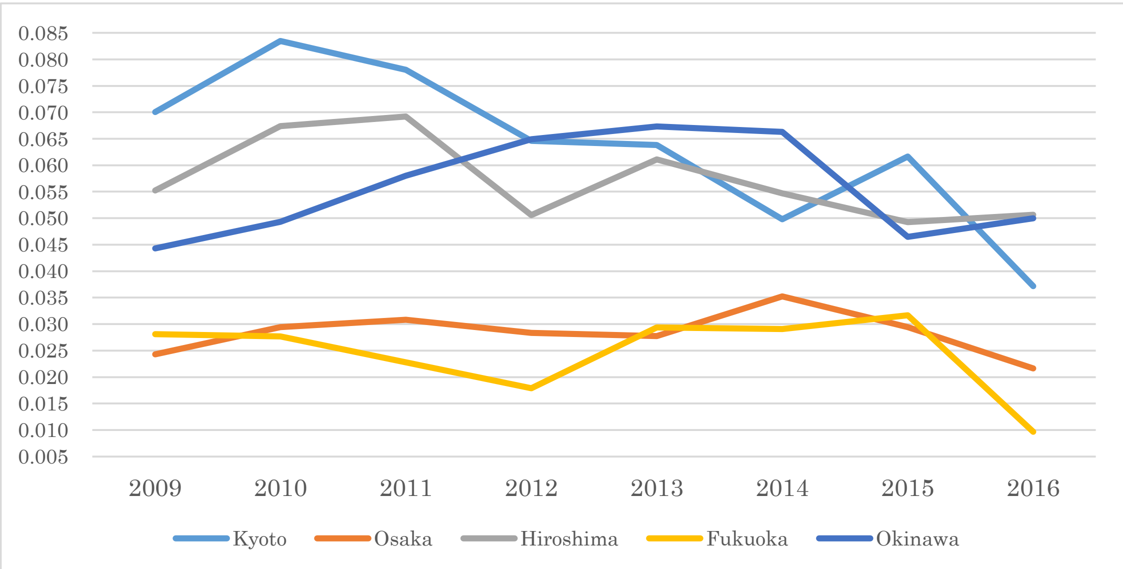
[1] The data on "approximate total number of overnight guests" can be retrieved from the website of the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism (http://www.mlit.zgo.jp/kankocho/siryou/toukei/shukuhakutoukei.html). The "amounts of rainfall," "average air temperature," and "total sunshine duration" were obtained from the Japan Meteorological Agency's website (https://www.data.jma.go.jp/gmd/risk/

Figure 2 (a): Seasonal Variation in Tourism Demand for Western Japan (Quarterly Basis)



Notes: The data for making this figure was obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/Siryou/toukei/shukuhakutoukei.html)

Figure 2 (b): Gini Index for the Prefectures in Western Japan (Quarterly Basis)



Notes: The data for making this figure was obtained from "Overnight Travel Statistics" (from 2008 to 2017) by the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism. (http://www.mlit.go.jp/kankocho/Siryou/toukei/shukuhakutoukei.html)

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obsdl/index.php#). The "consumer price index" is available from the "e-stat" website (https://www.e-stat.go.jp/dbview?sid=0003143513). The data on "Indices of Industrial Production (prefectural data)" can be retrieved from the website of the Ministry of Economy, Trade, and Industry (http://www.meti.go.jp/statistics/tyo/iip/chiiki/index.html).

V: approximate total number of overnight guests (accommodation facilities with 10 or more employees); prefectural data (Kyoto, Osaka, Hiroshima, Fukuoka, Okinawa), monthly, final figures (Transition Table in Table 4-2, result of the survey "Overnight Travel Statistics," January to December 2017, final report, the Japan Tourism Agency, Ministry of Land, Infrastructure, Transport, and Tourism).

R: amounts of rainfall (mm) at observation sites (in the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture)), monthly, issued by the Japan Meteorological Agency.

T: average air temperature (°C) at observation sites (in the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture)), monthly, issued by the Japan Meteorological Agency.

S: total sunshine duration (hours) at observation sites (in the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture)), monthly, issued by the Japan Meteorological Agency.

P: consumer price index, prefectural data (Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa), monthly, original index, all items, base year = 2015, issued by the Ministry of Internal Affairs and Communications.

I: indices of industrial production, prefectural data (Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa), monthly, original index, manufacturing (Item Number: 2A00000000) (Kyoto and Osaka), mining and manufacturing (Item Number: 2000000000) (Hiroshima, Fukuoka, and Okinawa), base year = 2010, issued by each prefectural government office and the Ministry of Economy, Trade, and Industry.

"V" is the proxy variable for tourism demand and "I" is the proxy variable for the level of vitalization of the regional economy. In addition, our empirical analysis focuses on western Japan, namely, on the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture). The climatic variables, R, T, and S were observed at the observation sites of the Japan Meteorological Agency in each area or city. In short, they represent a city-level or town-level data set. By contrast, the economic variables, V, P, and I reflect the prefectural data that were observed by several governmental offices. In this study, the prefectural data are regarded as proxy variables for city- or town-level data in conducting the empirical research based on the regional tourism.

For our empirical study, we implemented a GMM (Generalized Method of Moments) estimation by considering the measurement error and endogeneity of the variables, in addition to the correlation between the explanatory variables and the error term. Our GMM estimation was conducted with the assumption that the consumer price index for each area is endogenous, and with the Newey-West HAC (heteroskedasticity and autocorrelation consistent) weighting matrix to accommodate the possibility of serial correlation and heteroscedasticity. Concretely, our estimations were conducted by the following two types of specification ("ln" means the natural logarithm):

<Model (1)>

$$lnV_t = \alpha_0 + \alpha_1 lnR_t + \alpha_2 lnT_t + \alpha_3 lnP_t + \alpha_4 lnI_t + e_t,$$

<Model (2)>

$$lnV_t = \alpha_0 + \alpha_1 lnT_t + \alpha_2 lnS_t + \alpha_3 lnP_t + \alpha_4 lnI_t + e_t.$$

Instrument specifications regarding these two estimations are provided in the notes of Tables 6 and 7.

5. Empirical Results

We implemented a GMM (Generalized Method of Moments) estimation for Model (1) and Model (2), under the conditions and assumptions described in the former section. Further details regarding this estimation are provided in the notes of Tables 6 and 7. Since we should take a critical stance toward this type of estimation, Hansen's test for over-identification, the endogeneity test for variables, and the test for weak instrument variables utilizing Cragg-Donald statistic and Stock-Yogo critical values, were conducted.

The results of the endogeneity tests (Wu - Hausman test) for the variables in Models (1) and (2) of our estimations - ln(P), price level - for our areas of research interest are shown in Tables 2 and 3, respectively. The null hypotheses of exogeneity can be rejected at the conventional level by the test statistics for the case of Naha (in Okinawa prefecture) alone. This result means that our estimation Models (1) and (2) do not always fit well for the areas of interest, except for Naha, in terms of setting the endogenous variable. However, the main purpose of this research is to analyze the influence of climatic and economic variables on seasonal tourism variation as a type of spatial movement in several Japanese areas. Thus, we were obliged to proceed with the investigation, with careful attention to the possibility of an incomplete estimation model.

Further, to investigate the weak identification problem pointed out by some studies (including Mavroeidis (2004)), we used the Cragg and Donald (1993) statistic and the Stock and Yogo (2005) critical values[2]. In Table 4, the Cragg-Donald F-statistics of the five areas under consideration in Model (1) are apparently larger than the Stock-Yogo critical values for both relative bias and size. Thus, the null hypothesis of weak identification is rejected for each area. In addition, we can obtain the same result for Model (2) by considering Table 5. Therefore, the test results imply that the sets of instrumental variables for our two estimation models are valid.

Table 6 reports the GMM estimation results for the five areas under consideration, namely, Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in Okinawa), with respect to Model (1). Considering Hansen's diagnostic test, the null hypotheses of over-identification for the GMM estimation cannot be rejected, thus supporting the validity of the moment conditions, as shown by the J-statistic and the p-value in the table.

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[2] See Cragg and Donald (1993), Stock, Wright, and Yogo (2002), and Stock and Yogo (2002) for details.

Table 2: Endogeneity Test for Model (1)

Test instruments	Difference in J-statistics			Restricted	Unrestricted
	Value	d.f.	p-value	J-statistic	J-statistic
ln(P) for KYOTO	0.001137	1	0.9731	3.622982	3.621845
ln(P) for OSAKA	2.280432	1	0.1310	7.627244	5.346813
ln(P) for HIROSHIMA	0.069769	1	0.7917	5.814584	5.744814
ln(PO) for FUKUOKA	0.688497	1	0.4067	4.253648	3.565151
ln(PO) for NAHA	5.850323	1	0.0156	9.141542	3.291219

Table 3: Endogeneity Test for Model (2)

Test instruments	Difference in J-statistics			Restricted	Unrestricted
	Value	d.f.	p-value	J-statistic	J-statistic
ln(P) for KYOTO	0.002659	1	0.9589	3.599661	3.597002
ln(P) for OSAKA	0.368527	1	0.5438	1.931043	1.562516
ln(P) for HIROSHIMA	0.436444	1	0.5088	3.280394	2.843951
ln(P) for FUKUOKA	0.996301	1	0.3182	4.797472	3.801172
ln(P) for NAHA	3.100485	1	0.0783	5.488646	2.388161

Table 4: Weak Instrument Diagnostics for Model (1)

	Kyoto	Osaka	Hiroshima	Fukuoka	Okinawa
Cragg-Donald F-stat	387.4917	621.9983	550.7365	644.6691	561.6538
Stock-Yogo TSLS critical values (relative bias)					
5%	18.37				
10%	10.83				
20%	6.77				
30%	5.25				
Stock-Yogo critical values (size)					
10%	26.87				
15%	15.09				
20%	10.98				
25%	8.84				

Table 5: Weak Instrument Diagnostics for Model (2)

	Kyoto	Osaka	Hiroshima	Fukuoka	Okinawa
Cragg-Donald F-stat	522.1223	798.7839	676.8538	782.9972	745.3656
Stock-Yogo TSLS critical values (relative bias)					
5%	16.85				
10%	10.27				
20%	6.71				
30%	5.34				
Stock-Yogo critical values (size)					
10%	24.58				
15%	13.96				
20%	10.26				
25%	8.31				

Table 6: GMM Estimation for Model (1)

Variable	Coefficient for Kyoto	Coefficient for Osaka	Coefficient for Hiroshima	Coefficient for Fukuoka	Coefficient for Naha
C	-4.614378	-8.444575	-7.845590	-5.772492	-21.24247
std. error	8.169264	9.051577	4.081459	4.357503	5.173116
t-statistic	-0.564846	-0.932940	-1.922252	-1.324725	-4.106320
prob.	0.5733	0.3528	0.0571	0.1879	0.0001
lnI	-0.053257	-0.012658	-0.007516	0.002632	0.021971
std. error	0.027098	0.017901	0.022304	0.022119	0.014845
t-statistic	-1.965352	-0.707080	-0.336977	0.118984	1.480017
prob.	0.0518	0.4810	0.7368	0.9055	0.1417
ln(*T*)	0.152832	0.034756	0.176992	0.018060	0.475974
std. error	0.043960	0.053835	0.032241	0.039140	0.113259
t-statistic	3.476623	0.645611	5.489596	0.461434	4.202523
prob.	0.0007	0.5198	0.0000	0.6454	0.0001
ln(*P*)	3.746781	4.601562	4.685646	4.024557	6.929490
std. error	2.032413	2.020348	1.094210	1.024956	1.165738
t-statistic	1.843513	2.277608	4.282218	3.926567	5.944296
prob.	0.0679	0.0246	0.0000	0.0001	0.0000
ln(*I*)	0.263452	0.371284	-0.165525	0.232424	0.403180
std. error	0.318585	0.427801	0.307667	0.230923	0.136861
t-statistic	0.826943	0.867890	-0.538000	1.006501	2.945905
prob.	0.4100	0.3873	0.5916	0.3163	0.0039
weight iterations	9	10	13	19	5
s.e. of regression	0.227336	0.222925	0.193476	0.170578	0.167781
instrument rank	9	9	9	9	9
J-statistic	3.619882	4.640390	5.850846	3.752282	2.921277
prob(J-statistic)	0.459886	0.326224	0.210568	0.440568	0.571085

Notes: Instrument specification: $\mathrm{Constant},\ lnR_t,\ lnR_{t-1},\ lnT_t,\ lnT_{t-1},\ lnP_{t-1},\ lnP_{t-2},\ lnI_t,\ lnI_{t-1}$, Sample (adjusted): 2008:M03 – 2017:M12. Included observations = 118 (after adjustments). Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 5). Standard errors and covariance computed using HAC weighting matrix (Bartlett kernel, Newey-West fixed bandwidth = 5).

Table 7: GMM Estimation for Model (2)

Variable	Coefficient for Kyoto	Coefficient for Osaka	Coefficient for Hiroshima	Coefficient for Fukuoka	Coefficient for Naha
C	-8.624910	-18.10068	-4.741969	-8.051280	-23.17704
std. error	8.583699	7.618994	5.117800	3.762183	5.876944
t-statistic	-1.004801	-2.375731	-0.926564	-2.140055	-3.943723
prob.	0.3171	0.0192	0.3561	0.0345	0.0001
ln(*T*)	0.105964	0.007213	0.136608	-0.010439	0.422147
std. error	0.044736	0.049997	0.033653	0.045783	0.145409
t-statistic	2.368637	0.144263	4.059334	-0.228022	2.903177
prob.	0.0195	0.8855	0.0001	0.8200	0.0044
ln(*S*)	0.162462	0.230834	0.138073	0.126638	0.018337
std. error	0.063716	0.070414	0.057348	0.045021	0.046898
t-statistic	2.549775	3.278259	2.407618	2.812844	0.391007
prob.	0.0121	0.0014	0.0177	0.0058	0.6965
ln(*P*)	4.515104	6.525695	3.699646	4.500800	7.425631
std. error	2.178762	1.786953	1.328033	0.923435	1.301462
t-statistic	2.072326	3.651856	2.785808	4.873977	5.705608
prob.	0.0405	0.0004	0.0063	0.0000	0.0000
ln(*I*)	0.165876	0.301224	-0.004973	0.137256	0.366916
std. error	0.342871	0.438822	0.350609	0.235586	0.143904
t-statistic	0.483787	0.686439	-0.014183	0.582616	2.549733
prob.	0.6295	0.4938	0.9887	0.5613	0.0121
weight iterations	10	8	8	15	8
s.e. of regression	0.229657	0.221383	0.179335	0.173273	0.168073
instrument rank	8	8	8	8	8
J-statistic	3.574340	1.680483	3.057462	4.087280	2.333840
prob(J-statistic)	0.311248	0.641281	0.382850	0.252192	0.506069

Notes: Instrument specification: $\mathrm{Constant},\ lnT_t,\ lnT_{t-1},\ lnS_t,\ lnS_{t-1},\ lnP_{t-1},\ lnI_t,\ lnI_{t-1}$, Sample (adjusted): 2008:M02 – 2017:M12. Included observations = 119 (after adjustments). Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 5). Standard errors and covariance computed using HAC weighting matrix (Bartlett kernel, Newey-West fixed bandwidth = 5).

With regard to the estimated parameters of Model (1) for Kyoto, the coefficient of R is barely significant at the 10% level, with our expected sign. The coefficient of T is significant at the 1% level, and the coefficient of P is also significant, but the level of significance is 10%. The signs of T and P are controversial. By contrast, I is apparently insignificant. This result implies that rainfall is a negative factor for tourism in Kyoto, although temperature and price level are positive elements. As for Osaka and Fukuoka, only the coefficient of P is significant. In this respect, the estimation results for Osaka and Fukuoka do not have any positive implications. The estimated parameters of T and P for Hiroshima are significant at the 1% level. Thus, temperature and price level are positive factors. However, we cannot determine the effects of rainfall and vitalization of the regional economy on tourism of Hiroshima. By contrast, Naha's coefficients on T, P, and I are sufficiently significant at the 1% level, but R is not significant at the conventional level. Therefore, temperature, price level, and vitalization of the regional economy may enlarge the number of visitors to Naha (in the Okinawa Prefecture), although nothing can be concluded with respect to the effect of rainfall.

Overall, we cannot find any areas in our investigation that correspond entirely to estimation Model (1). However, Model (1) relatively fits with Kyoto and Naha. In addition, it still needs further work to consider the signs of the estimated coefficients on temperature and price level, as well as the causality between these two factors and the number of visitors.

Table 7 reports the estimation result by the GMM method for the five focus areas of Model (2). By considering the J-statistic and the p-value in the table, we can determine that the null hypotheses of over-identification for GMM estimation cannot be rejected by Hansen's test, and that the validity of the moment conditions is supported.

With respect to the parameter estimation based on Model (2) for Kyoto, the coefficients on T, S, and P are significant at the 5% level, while the one on I is apparently insignificant. This result implies that temperature, sunshine duration, and price level are positive elements for tourism in Kyoto. As for Osaka and Fukuoka, S, and P are significant at the 1% level, while the others are not. In this respect, we find that sunshine duration and price level are positive factors for tourism in Osaka and Fukuoka. The coefficients on T and P are significant at the 1% level, and that of S is significant at the 5% level in the case of Hiroshima. I is insignificant. Thus, temperature, sunshine duration, and price level can be regarded as positive factors for Hiroshima's tourism, although we cannot determine the effects of vitalization of the regional economy. By contrast, the coefficients on T and P for Naha are noticeably significant at the 1% level, and the one on I is significant at the 5% level. However, S is not significant at the conventional level, and this result might contradict our intuition in general. Thus, temperature, price level, and vitalization of the regional economy may increase the number of visitors to Naha (in the Okinawa Prefecture), although nothing can be concluded about the effect of sunshine duration.

On the whole, Model (2) fits Kyoto, Hiroshima, and Naha relatively well. As for Model (1), we need to consider the signs of the estimated coefficients on temperature and price level, as well as the causality between these two factors and the number of visitors.

6. Concluding Remarks

This study investigated the influence of climatic and economic variables on tourism in several areas in western Japan. For our empirical study, the GMM (Generalized Method of Moments) estimations based on two kinds of specifications (Model (1) and Model (2)) were implemented, considering the measurement error and endogeneity of the variables, in addition to the correlation between the explanatory variables and the error term. Our GMM estimations were made under the assumption that the consumer price index is endogenous, and with the Newey-West HAC (heteroskedasticity and autocorrelation consistent) weighting matrix to accommodate the possibility of serial correlation and heteroscedasticity.

The estimated parameters of Model (1) imply that rainfall is a negative factor for Kyoto's tourism, while temperature and price level are positive elements. Positive implications cannot be derived for Osaka and Fukuoka. While temperature and price level are positive factors, we cannot determine the effects of rainfall and vitalization of the regional economy on Hiroshima's tourism. For Naha (in the Okinawa Prefecture), temperature, price level, and vitalization of the regional economy may increase the number of visitors; however, no conclusions can be drawn about the effect of rainfall.

The Model (2) estimations for Kyoto imply that temperature, sunshine duration, and price level are positive tourism elements. By contrast, we find that sunshine duration and price level are positive factors for Osaka and Fukuoka's tourism. With respect to Hiroshima, temperature, sunshine duration, and price level can be regarded as positive factors, although the effects of vitalization of the regional economy cannot be determined. For Naha, temperature, price level, and vitalization of the regional economy may increase the number of visitors; however, nothing can be concluded in terms of the effect of sunshine duration.

Note that we cannot find any areas of investigation that fits the estimation Models (1) and (2) entirely. Further work is required to consider the signs of the estimated coefficients on temperature and price level, as well as the causality between these two factors and the number of visitors. In this respect, it is clear that many issues remain unanswered.

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