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Estimating the Effect of Meteorological and Economic Factors on Tourism Demand Seasonality in Japan

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ABSTRACT

The tourism seasonality expressed by fluctuated number of visitors to a destination is affected by various factors. Focusing on this aspect, this paper examines the tourism seasonality of western region in Japan including Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa (or city of Naha in Okinawa prefecture) with the data that possibly be the meteorological fundamentals and the economic factors. Concretely, the empirical investigation based on the panel data analysis by applying the so-called "two-way fixed effects model" is implemented.

The empirical examination derives the results as follows. The estimation result of model 1 implies that the sightseeing place with small amount of rain might obtain comparatively a large tourism demand. The average air temperature and the level of vitalization of regional economy do not work as the factors to get the tourism demand. The estimation result based on the model 2 might describe that the tourism destination with comfortable temperature is able to attract a large tourism demand, and the one with ample sunshine also has a chance to obtain a large number of tourists. From a different aspect, meteorological factors might have a certain impact on tourism demand but the economic variables that possibly be the seasonal factors are not the critical determinants of tourism demand in Japan's western region.

Key words: Tourism, Tourism demand, Seasonality, Panel regression
JEL Classification Code: C33, L83, O18, R58, Z38

1. Introduction

The aim of this study is to investigate how meteorological (or climatic) and economic factors affect tourism demand fluctuations and seasonality in western Japan's typical tourism destinations. Seasonal tourism fluctuation can be a serious problem since this topic is critical in that it destabilizes the employment, tourism businesses, and the regional economy. In addition, various strategies and evaluations on tourism management should be individually determined because some causes of tourism seasonality, which are related to natural- and socio-economic factors, do not correspond with one another. In this respect, a policy to mitigate seasonal fluctuation is required for stable and profitable management (Lee *et al.* (2008)). In this paper, we analyze the factors that cause seasonal changes in tourism, focusing on climate and economic factors. Policies that mitigate seasonal variations in tourism depend on what causes seasonal variations.

What causes the seasonal variation in tourism? The primary factor of seasonal variation is based on the geographical environment and the climatic condition. Regarding this matter, Cuccia and Rizzo (2011) analyze seasonality as one of the main phenomena having an effect on tourism and insist that it depends on the features of both tourism demand and tourism destinations from the aspect of location and services supplied. On the other hand, Kulendran and Dwyer (2010, 2012) focus on economic factors in addition to some meteorological elements when they examine the influence of seasonal fluctuations on tourism. One of the essential literatures for studying seasonal variations in tourism is Baum and Lundtorp (2001). They give a comprehensive analysis of the seasonal variation in tourism in terms of tourism facility managements. Butler (2001) overviews the cause and effect of seasonal variations on tourism by pointing out the practical difficulties of mitigation of variations. To carry on the spirits of these studies, our research focuses on meteorological and economic factors to examine the tourism demand in western region of Japan.

In this research, panel data analysis is conducted to analyze the tourism demand fluctuation with the balanced panel data set. Technically, it is hard to make an exhaustive investigation of seasonality on tourism demand by a simple panel data estimation. In this respect, we apply the so-called "two-way fixed effects model" that reflects the individual effects and the period (time) effects on panel data regression. The implication of our result can be used to investigate the efficient operation of tourism facilities and infrastructures as the regional economic policy at the micro- and macro-levels.

The remainder of this paper is organized as follows. In Section 2, panel unit root test and panel regression analysis by applying two-way fixed effects model are implemented. Finally, Section 3 summarizes our research.

2. Panel Regression Analysis

2.1 The Data

This section describes the data set used in our empirical panel data analysis for the influence of meteorological and economic variables on tourism in Japanese western region. In our panel data set, each variable includes 12 units (monthly series), and each unit has 120 months of data (from January 2000 to December 2017), and 5 cross-sections are included – the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture). Our dataset is composed of the following variables.[1]

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," (second preliminary estimate) 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 region in Japan, namely, on the cities of Kyoto, Osaka, Hiroshima, Fukuoka, and Naha (in the Okinawa prefecture). The meteorological variables, R, T, and S were observed at the observation sites of the Japan Meteorological Agency in each area or city. Therefore, they represent a city-level or town-level data set. By contrast, the economic variables, V, P, and I reflect the prefectural-level data that were observed by several local governmental offices. In this study, the prefectural-level items are regarded as proxy variables for city- or town-level data for the empirical research based on the regional tourism.

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[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/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).

In our study, logarithmic transformation (natural logarithm) is performed on all the variables listed above, and a first difference of "*P*" ($lnP_t - lnP_{t-1}$) is taken in order to have the inflation rate (monthly change).

2.2. Panel Unit Root Test

In this section, we conduct the seasonal unit root test considering the chance that seasonal pattern of the variables may change permanently due to some shocks.[2] We apply the panel unit root test proposed by Im, Pesaran, and Shin (2003). The specification of this test[3] is as follows:

$$\Delta\gamma_{i,t} = \alpha_i + \rho_i \gamma_{i,t-1} + \sum_{k=1}^{n} \emptyset_k \Delta\gamma_{i,t-k} + \delta_i t + \theta_t + u_{i,t}, \qquad (1)$$

($i = 1, \ldots, N$ and $t = 1, \ldots, T$)

where γ: variable to be tested, α: intercept of unit element of panel, i: unit element of panel, t: time element of panel, ρ: coefficient to be tested for unit root, θ: intercept of time element of panel, u: residual.

Im, Pesaran, and Shin's (2003) test needs separate Augmented Dickey-Fuller (ADF) unit root tests for the *N* cross-section units, and their final test statistic is the average of each statistic across groups by following a normal distribution. The null hypothesis is that all units are non-stationary, and the alternative hypothesis is that a fraction of the series in the panel is to be stationary. In our study, if the test result shows a non-stationary pattern, first order or the eventual order of differencing of the variable and panel cointegration analysis should be considered.

The result of the Im, Pesaran, and Shin's (2003) test is described in Table 1. The test statistics in this table show the rejections of the null hypothesis[4] at conventional level of significance, and the clear signs of being $\mathrm{I}(0)$ for all variables. Therefore, we need not consider the differencing of the variables and panel cointegration test.

2.3. Estimation by the Two-way Fixed Effects Model

With the characteristics of the variables known, our research proceeds to examine whether the meteorological and economic fundamentals are the determinants of tourism demand for the Japanese western region by panel regression analysis.

The standard linear regression for panel data analysis can be written as

$$y_{it} = \beta_0 + x'_{it}\beta + \varepsilon_{it}, \qquad (2)$$

where x_{it} is a *K*-dimensional vector of independent variables. An *i* is for the individual ($i = 1, \ldots, N$) and a *t* is for the time period ($t = 1, \ldots, T$). The constant term β_0 and the slope coefficient β are identical for all individuals and for time periods. The error term ε_{it} changes over individuals and time, and it captures all unobservable elements that affect the dependent variable.

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[2] See Hylleberg, Engle, Granger, and Yoo (1990) for details.

[3] The explanation of the model of Im, Pesaran, and Shin (2003) in this section is partially based on Asteriou (2015).

[4] Rejection of null hypothesis for Im, Pesaran, and Shin's (2003) test means that some series are stationary or converging to their means over time.

Table 1: Im, Pesaran and Shin Test (Exogenous variables: Individual effects, individual linear trends)

Variable (level)	test statistic	p-value	optimal lag for intermediate tests
$ln\ V$	-2.22322	0.0131	0 to 12
$ln\ R$	-8.33159	0.0000	0 to 36
$ln\ T$	-3.33811	0.0004	0 to 0
$ln\ S$	-17.7075	0.0000	0 to 1
$ln\ P - ln\ P(-1)$	-13.7518	0.0000	1 to 12
$ln\ I$	-4.30128	0.0000	0 to 11

Notes: Optimal lag length for intermediate ADF test is determined based on the modified AIC criterion. P-values are computed by assuming asymptotic normality.

The random effects model is described by equation (2) and the assumption:

$$\varepsilon_{it} = \alpha_i + u_{it}, \qquad (3)$$

where u_{it} is presumed to be homoscedastic and uncorrelated over time. The α_i is time invariant and homoscedastic across individuals. This model also assume that the observable regressors in x_{it} are not correlated with the unobservable elements in both α_i and u_{it}: in short, $E\{x_{it}\, \varepsilon_{it}\} = 0$.

The fixed effects model includes individual-specific constant terms. Thus, the fixed effects model is described by

$$y_{it} = \alpha_i + x'_{it}\beta + u_{it}, \qquad (4)$$

where α_i are fixed unknown constants that are estimated along with β, and u_{it} is usually assumed to be *i.i.d.* over individuals and time. The individual intercepts α_i are often expressed as fixed (individual) effects and grasp all unobservable time-invariant differences across individuals. Further, $E\{x_{it}\varepsilon_{it}\} \neq 0$ is assumed.

In our empirical research, the following two types of specification are applied ("ln" means the natural logarithm):

<Model 1>

$$lnV_t = \alpha_0 + \alpha_1 lnR_t + \alpha_2 lnT_t + \alpha_3(lnP_t - lnP_{t-1}) + \alpha_4 lnI_t + e_t, \qquad (5)$$

<Model 2>

$$lnV_t = \alpha_0 + \alpha_1 lnT_t + \alpha_2 lnS_t + \alpha_3(lnP_t - lnP_{t-1}) + \alpha_4 lnI_t + e_t. \qquad (6)$$

First, we should detect which is better for us to choose the fixed effects model or the random effects model. The random effects model can be consistently estimated by both the fixed effects and the random effects estimators. The random effects estimator would be preferred if we are sure that the individual specific effect is certainly an unrelated effect, in short, the individual specific effect is random, and it is uncorrelated with the explanatory variables for all past, current, and future periods of the same person. The Wu-Hausman test[5] is constructed to find violation of the assumption for the random effects model that the independent variables are orthogonal to the unit (individual) effects. If no correlation is found between the

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[5] The explanation of the Wu-Hausman test in this section is mainly based on Greene (2017) and Verbeek (2018).

independent variables and the unit effects, then $\hat{\beta}_{FE}$, estimates of β in the fixed effects model, would be close to $\hat{\beta}_{RE}$, estimates of β in the random effects model. The test statistic H describes the difference between these two estimates:

$$H = (\hat{\beta}_{RE} - \hat{\beta}_{FE})'[Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})]^{-1}(\hat{\beta}_{RE} - \hat{\beta}_{FE}), \qquad (7)$$

with the condition under the null hypothesis:

$$Var(\hat{\beta}_{FE} - \hat{\beta}_{RE}) = Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE}). \qquad (8)$$

H follows chi-square distribution with degrees of freedom that equal to the number of regressors under the null hypothesis of orthogonality. Rejection of null hypothesis[6] implies that the two models are different enough, and we do not prefer the random effects model.

The results of the Wu-Hausman tests for our two models (model 1 and model 2) are indicated in Table 2-1 and Table 2-2. The test statistics show the rejection of null hypotheses at 1% level of significance. Considering these results, we prefer the fixed effects model for our two kinds of estimation. However, the Wu-Hausman test has some weak points. For example, it is only valid under *i.i.d.* of error term and cannot include time (period) fixed effects. Accordingly, we focus on the latter problem. In other words, we implement the redundant fixed effects tests to detect the existence of both cross-section and period fixed effects. Table 3-1 depicts the result of the test for model 1 and Table 3-2 shows the result for model 2, respectively. The test statistics reveal that the null hypotheses with regard to the individual fixed effects and the period fixed effects are rejected. In addition, the joint null hypotheses are also rejected. These results imply that there exist the individual effects[7] and the period (time) effects in the context of the fixed effects model. Therefore, we have to choose the so-called "two-way fixed effects model," rather than the usual one-way fixed effect model for our estimation. The two-way fixed effects model is described by the specification:

$$\mathrm{Y}_{it} = \alpha + \beta x_{it} + \gamma_i + \mu_t + \varepsilon_{it}, \qquad (9)$$

$$\varepsilon_{it} \sim N(0, \sigma^2), \qquad (10)$$

where γ_i is for the individual fixed effects, and μ_t stands for the period fixed effects.

The results of the estimations for model 1 and model 2 by following the "two-way fixed effects model" using our balanced panel data set are displayed in Table 4-1 and Table 4-2. Considering the result of model 1, only two variables (except constant term) are significantly estimated and the other variables are insignificant among the explanatory variables that reflect meteorological and economic conditions of western region of Japan. The rainfall as the meteorological factor is significant at 1% level of significance with a negative sign. On the other hand, the inflation rate as an economic element is barely significant at 10% level with a positive sign. If we enlarge on these points, we have the following implications. In the

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[6] Precisely speaking, rejection of null hypothesis should not directly be the evidence for the comparative advantage of the fixed effects model. For the lower power with respect to the severe pretest bias of the Wu-Hausman test, see Guggenberger (2010).

[7] Because of the existence of individual fixed effects, pooled estimation is inappropriate for us.

Table 2-1: Wu-Hausman Test for model 1

chi-sq. statistic	chi-sq. d.f.	p-value
1833.479672	4	0.0000

Table 2-2: Wu-Hausman Test 2 for model 2

chi-sq. statistic	chi-sq. d.f.	p-value
1909.522834	4	0.0000

Table 3-1: Redundant Fixed Effects Tests (cross-section and period fixed effects) for model 1

F / χ^2	Statistic	d.f.	p-value
cross-section F	2159.367481	(4,468)	0.0000
cross-section χ^2	1766.056572	4	0.0000
period F	19.645116	(118,468)	0.0000
period χ^2	1061.443252	118	0.0000
cross-section / period F	90.453778	(122,468)	0.0000
cross-section / period χ^2	1905.146109	122	0.0000

Table 3-2: Redundant Fixed Effects Tests (cross-section and period fixed effects) for model 2

F / χ^2	Statistic	d.f.	p-value
cross-section F	2176.697085	(4,468)	0.0000
cross-section χ^2	1770.569053	4	0.0000
period F	19.453353	(118,468)	0.0000
period χ^2	1056.591122	118	0.0000
cross-section / period F	92.627406	(122,468)	0.0000
cross-section / period χ^2	1918.706703	122	0.0000

season that the sightseeing area has small amount of rain, the area might obtain comparatively a large tourism demand. The average air temperature and the level of vitalization of regional economy do not work at all in the case of model 1.

With respect to the model 2, two variables (except constant term) are significant. The average air temperature is significantly estimated at 5%, while the total sunshine duration is significant at 1%. These two have positive sighs. This result might describe that the tourism destination with comfortable temperature is able to attract a large tourism demand, and the one with ample sunshine has a chance to obtain a large number of tourists. From a different aspect, meteorological factors might have certain impacts on tourism demand while the economic variables that possibly be the seasonal factors are not the crucial determinants of tourism demand in Japan’s western region.

On the whole, the result of model 1 shows that the rainfall as the meteorological factor is significant at 1% level of significance with a negative sign and the inflation rate as an economic element is barely significant at 10% with a positive sign. This result implies that the sightseeing place with small amount of rain might obtain comparatively a large tourism demand. The average air temperature and the level of vitalization of regional economy do not work as the factors to get tourism demand. The estimation result

Table 4-1: Panel Regression Analysis (with cross-section and period fixed effects) for model 1

effects specification: cross-section fixed and period fixed effects (two-way model)				
variable	coefficient	std. error	t-statistic	p-value
const.	13.93036	0.254616	54.71121	0.0000
$\ln R$	-0.029911	0.008241	-3.629442	0.0003
$\ln T$	0.012778	0.028989	0.440781	0.6596
$\ln P - \ln P(-1)$	4.659875	2.504988	1.860238	0.0635
$\ln I$	0.011936	0.060871	0.196082	0.8446
R-squared	0.962168	Log likelihood	611.0713	
Adj. R-squared	0.951983	F-statistic	94.46456	
S.E. of regression	0.097695	Prob (F-statistic)	0.000000	
Sum squared resid.	4.466760			

Notes: Dependent Variable: visitors. Method: Panel Least Squares. Sample: 2000: M1 (January) – 2017: M12 (December). Periods included: 119. Cross-sections included: 5. Total panel (balanced) observations: 595.

Table 4-2: Panel Regression Analysis (with cross-section and period fixed effects) for model 2

effects specification: cross-section fixed and period fixed effects (two-way model)				
variable	coefficient	std. error	t-statistic	p-value
const.	13.01391	0.293187	44.38777	0.0000
$\ln T$	0.060386	0.030563	1.975757	0.0488
$\ln S$	0.128705	0.025045	5.138918	0.0000
$\ln P - \ln P(-1)$	3.519560	2.464457	1.428128	0.1539
$\ln I$	0.011319	0.060051	0.188491	0.8506
R-squared	0.963181	Log likelihood	619.1441	
Adj. R-squared	0.953268	F-statistic	97.16516	
S.E. of regression	0.096379	Prob (F-statistic)	0.000000	
Sum squared resid.	4.347182			

Notes: Dependent Variable: visitors. Method: Panel Least Squares. Sample: 2000: M1 (January) – 2017: M12 (December). Periods included: 119. Cross-sections included: 5. Total panel (balanced) observations: 595.

based on the model 2 might describe that the tourism destination with comfortable temperature is able to attract a large tourism demand, and the one with ample sunshine has a chance to obtain a large number of tourists. From a different perspective, in Japan's western region, meteorological factors might have certain impacts on tourism demand but the economic variables that possibly be the seasonal factors are not the critical determinants of tourism demand.

3. Concluding Remarks

The tourism seasonality expressed by fluctuated number of visitors to a destination is affected by various factors. Focusing on this aspect, this paper examines the tourism seasonality of western region in Japan including Kyoto, Osaka, Hiroshima, Fukuoka, and Okinawa (or city of Naha in Okinawa prefecture) with the data that possibly be the meteorological fundamentals and the economic factors. Concretely, the empirical investigation based on the panel data analysis by applying the so-called "two-way fixed effects model" is implemented.

The empirical examination by the panel data analysis based on "two-way fixed effects model" derived the results as follows. The estimation result of model 1 (with rainfall, temperature, inflation rate, and level of vitalization of the regional economy, as the explanatory variables) shows that the rainfall as the meteorological factor is significant at 1% level of significance with a negative sign and the inflation rate as an economic element is barely significant at 10% with a positive sign. This result implies that the sightseeing place with small amount of rain might obtain comparatively a large tourism demand. The average air temperature and the level of vitalization of regional economy do not work as the factors to get the tourism demand. The estimation result based on the model 2 (with temperature, sunshine duration, inflation rate, and level of vitalization of the regional economy, as the explanatory variables) might describe that the tourism destination with comfortable temperature is able to attract a large tourism demand, and the one with ample sunshine has a chance to obtain a large number of tourists. From a different aspect, meteorological factors might have certain impacts on tourism demand but the economic variables that possibly be the seasonal factors are not the critical determinants of tourism demand in Japan's western region.

The implication of our result might be applied to the efficient operation of tourism facilities and infrastructures as the regional economic policy at the micro- and macro-levels. However, a natural extension and further investigation of our research are required since the empirical analysis in this paper has some unclear results.

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