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Long Memory and Multiple Structural Breaks in the Returns of Travel and Tourism Indexes

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Abstract: This study identifies the long memory process and multiple structural breaks among travel and tourism indices at the New Zealand Stock Exchange, Dow Jones, and Financial Times Stock Exchange at the London Stock Exchange. The autoregressive fractionally integrated moving average-fractionally integrated generalized autoregressive conditional heteroskedasticity model and structural breaks are used to examine the long memory process. Almost all variables have intermediate memory except for Dow Jones US Travel and Tourism, which has long memory. More than 90% of the tourism and travel indices have structural breaks and interconnection among indices from New Zealand, the US, and Europe. New Zealand and Europe have strong asymmetrical effects.

Key words: long memory; multiple structural breaks; tourism
JEL code: G15

1. Introduction

On 9 July 2012, the United Nations World Tourism Organization (UNWTO) released the figures for *i*nternational tourist arrivals worldwide. This number grew by 5% in the first four months of 2012, although economic uncertainties remain in several major outbound markets. The tourism and travel industry has contributed to economic growth in many countries. The UNWTO World Tourism Barometer indicates that the summer peak season in the northern hemisphere attracts approximately 415 million international tourists yearly.

This study investigates tourism and travel indices to determine the relation between tourism and economic and social phenomena. For many decades, tourism has been one of the fastest growing economic sectors and has facilitated economic growth. Tourism is closely connected to growth and encompasses an increasing quantity of new destination. These conditions make tourism a key driver of social economic growth. The business volume of tourism equals or even surpasses that of oil exports, food products, and automobiles.

Tourism has developed into one core worldwide industry and represents one major source of income for many developing countries. Tourism growth enhances the diversification of and competition between tourism destinations. It also facilitates the raising of revenue of countries. UNWTO has given considerable attention to enhancing tourism sustainability, particularly in developing countries.

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Time series data from along memory process have been collected in the macroeconomic and financial economic contexts. Hurst (1951) pioneered research on long memory in water levels in the Nile River. Aydogan and Booth (1988) and Greene and Fielitz (1977) obtained long memory by the rescaled variety statistics of Hurst (1951) and found evidence of the long memory of US stock returns. Wright (1998) studied the discovery of evidence on long memory in stock returns in emerging markets, such as Greece, Chile, Philippines, Korea, and Colombia. Olan (2002) confirmed that long memory can be established in the South Korean, German, Japanese, and Taiwanese stock markets. However, Lo (1991) found no support for long memory in US stock returns. Therefore, the current study uses long-memory effects to examine travel and tourism indices in the New Zealand, American, and European markets. Furthermore, this study aims to confirm structural changes in the travel and tourism indices. Granger and Joyeux (1980) and Charfeddine and Guégan (2011) used the autoregressive fractionally integrated moving average (ARFIMA), Markov switching, and structural change models and found that break dates coincide with several economic and financial events. They also confirmed that breaks provoke spurious long memory behavior.

This study aimed to provide unique empirical evidence of long memory and structural breaks in the returns of travel and tourism indices. The study found substantial evidence to examine the asymmetric effects on these indices. Using ARFIMA and ARFIMA-fractionally integrated generalized autoregressive conditional heteroskedasticity (FIGARCH) to test long memory and the test of iterated cumulative sum squares (ICSS) to evaluate multiple structural breaks, this study found that US travel and tourism indices have long-memory effects, but New Zealand and European indices have intermediate to long memory. Interestingly, a structural break test showed that all travel and tourism indices have structurally changed.

The article is organized as follows: section II describes the data and methodology, section III presents the empirical results of long memory and structural breaks, and section IV provides the conclusion.

2. Data and Methodology

This study uses daily closing prices on travel and tourism indices obtained from the Yahoo! Finance website. Only eight tourism and travel indices are found. We acquire two trading indices from the New Zealand Stock Exchange (NZSE), four from Dow Jones Industrial (DJI), and two from the Financial Time Stock Exchange (FTSE) at the London Stock Exchange. The study period begins on varying index inception dates and ends on 13 July 2012.

The ARFIMA-FIGARCH model is used to investigate long memory. The ICCS method is used to analyze structural breaks.

(1) ARFIMA

Box and Jenkins (1970) proposed the autoregressive moving average model [ARMA (p, q)], where p is the autoregressive item and q is the moving average item, to illustrate stationary time series. The mean, auto-covariance, and variance of the ARMA model are constant and unaffected by time. However, most financial time series are non-stationary, implying that the time series have a non-stationary mean and auto-covariance. The autoregressive integrated moving average model [ARIMA (p, d, q)] proposed by Box and Jenkins (1970) uses parameter d to differentiate time series variables to make them stationary. To observe whether time series data have a long-memory effect, Engle and Granger (1987) indicated that imperfect d in zero or one causes an equilibrium error and thus reduces the ability to determine the long-memory effect. Granger and Joyeux (1980) proposed ARFIMA (p, d, q), which allows d to be anon-integer or fraction. If $0 < d < 0.5$, then d represents a time series with a long-memory effect. The mathematical model is expressed as:

$$\Phi(L)(1-L)^d(y_t-\mu_t)=\Psi(L)\varepsilon_t \quad (1)$$

Where d represents the fractional-integration real-number parameter, L is the lag operator, and ε_t is a noise residual.

$\Phi(L)=1-\Phi_1 L-\cdots-\Phi_p L^p=1-\sum_{j=1}^{p}\Phi_j L^j$ refers to the polynomials in the lag operator of order p, whereas $\Psi(L)=1+\sum_{j=1}^{p}\Psi_j L^j$ refers to the polynomials in the lag operator of order q (p and q are integers). ε_t is a white noise residual, and μ_t is the mean of y_t.

The fractional differencing lag operator $(1-L)^d$ can further be illustrated by the following expanded equation:

$$(1-L)^d=1-dL+\frac{d(d-1)}{2!}L^2-\frac{d(d-1)(d-2)}{3!}L^3+.. \quad (2)$$

The ARFIMA model uses d to capture the long memory of the time series variable. Paul et al. (2009) observed that when $d = 0$, the variable has short memory, and the effect of shocks toε_t decays faster (i.e., geometric decay). When $-0.5 < d < 0.5$, the variable is stationary, that is, the effect of market shocks to ε_t gradually decays to zero (i.e., hyperbolic decay). When $d = 1$, a unit root process occurs.

Hsieh and Lin (2004) showed that intermediate memory exists when $-0.5 < d < 0$, indicating that the autocorrelation function decays slowly. Short memory exists when $d = 0$, indicating that the autocorrelation function decays fast. If $0 < d < 0.5$, the time series has a long-memory effect. The time series variable is non-stationary when $d \geq 0.5$, but it is stationary when $d \leq 0.5$.

Three methods are used to analyze: (1) exact maximum likelihood estimation (exact MLE), (2) modified profile likelihood estimation, and (3) nonlinear least squares. Sowell (1992) observed that exact MLE outperforms the other methods when the sample data are small or medium-sized.

The ARFIMA model enhances performance in predicting volatility. Cheng (2006) and Sivakumar and Mohandas (2009) found that the predictive power of the ARFIMA model is moderately better than that of ARMA and ARIMA.

(2) FIGARCH

Engle (1982) proposed the autoregressive conditional heteroskedasticity (ARCH) model to illustrate the variance of residual changes over time and volatility clustering. Bollerslev (1986) proposed the generalized ARCH (GARCH) model and established that the square of the prior residual manipulates not only the conditional variance but also the prior variance. In modeling conditional variance, GARCH is more flexible than ARCH.

Baillie et al. (1996) proposed the fractional integrated GARCH (FIGARCH) model to capture long memory in volatility returns. Volatility gradually decays to zero (i.e., hyperbolic decay). If the variables have long memory, the random external shock in every period for these variables reacts slowly. For random external shock, stationary variables decay fast (i.e., geometric decay).

To obtain more elastic model for measuring the conditional variance and capturing the covariance of both the stationary GARCH for $\bar{d} = 0$ and the non-stationary IGARCH for $\bar{d} = 1$, the FIGARCH model is expressed as:

$$\phi(L)(1-L)^d\varepsilon_t^2=\omega+[1+\beta(L)]\upsilon_t \quad (3)$$

Where

$$(1-L)^d=\sum_{k=0}^{\infty}\frac{\Gamma(d+1)L^k}{\Gamma(k+1)\Gamma(d-k+1)} \quad (4)$$

$$(1-L)^d = 1 - dL - 2\frac{1}{2}d(1-d)L^2 - \frac{1}{6}d(1-d)(2-d)L^3 + \cdots \quad (5)$$

$(1-L)^d = \sum_{k=1}^{\infty} C_k(d)L^k$, (6) and $0 \le d \le 1$ is the fractional differencing parameter.

The FIGARCH model generally has the desired result in predicting volatility. Beine et al. (2002) and Lu (2007) found that the projecting power of the FIGARCH model is better than that of GARCH and IGARCH.

(3) Structural Break

In regression analysis, we assume that the variable does not exist in structural breaks. Thus, the parameter in the regression function exists in stable and stationary conditions. Under economic structure changes, economic variables are influenced by external shocks, such as an oil crisis and changes in monetary policy. The parameter does not exist in unstable and non-stationary conditions.

Non-stationary time series variables may exist in one or multiple structural breaks. The ICSS test proposed by Inclan and Tiao (1994) is adopted to identify sudden changes to the unconditional volatility of a series. Therefore, the variance of the series is assumed to remain constant until volatility abruptly changes. After this point, the variance is assumed to remain constant until volatility abruptly changes again. This series must be uncorrelated with the mean zero and variance σ_t^2.

$$\begin{aligned} \sigma_t^2 &= \xi_0 \quad 1 < t < k_k \\ &= \xi_1 k_1 < t < k_3 \\ &= \xi_{N\xi} < t < k_T, \end{aligned} \quad (6)$$

Where $1 < k_1 < k_1 < \cdots < k_{NT} < T$ refers to the various points where variance changes, N_T is the total number of changes, and ξ_j is the variance in each period ($j = 0,1,\ldots,N_T$).

Inclan and Tiao (1994) calculated statistic D_k on the basis of the cumulativesum of the squares of the series to detect the amount and time point of the changes.

$$C_k = \sum_{t=1}^{k} X_t^2 \quad (7)$$

$$D_k = \left(\frac{C_k}{C_T}\right) - \frac{k}{T}, k = 1, \ldots, T; D_0 = D_T = 0 \quad (8)$$

Where C_k and C_T are the mean-centered cumulative sums of the squares designated as k and T observations, respectively.

If variance does not change over the sample period, then series D_k oscillates around zero and drifts up or down from zero when variance shifts. The quantity $(\left(\frac{T}{2}\right) D_k)^{\frac{1}{2}}$ converges in distribution to a standard Brownian motion. The change point of variance over the interval $t = 1,\ldots$, T is the point k_0 at which $(\left(\frac{T}{2}\right) D_k)^{\frac{1}{2}}$ reaches its maximum and $(\left(\frac{T}{2}\right) D_k)^{\frac{1}{2}} > C_\alpha$, where C_α is a breaking value. At the 5% level, the breaking value is 1.358 (Inclan & Tiao, 1994).

For any time t_1 and t_2 with $t_1 < t_2$, notation X $[t_1{:}t_2]$ is usedto indicate extracted series $\{X_{t1}, X_{t+2}, \ldots, X_{t2}\}$, and $D_k(X[t_1{:}t_2])$ is denoted by the D_k value calculated from $\{X_{t1}, X_{t+2}, \ldots, X_{t2}\}$. First we set $t_1 = 1$.

To compute $D_k(X[t_1{:}T])$, let $k^*(X[t_1{:}T])$, which denotes the point where $\max_k |D_k[t_1{:}T]|$ is reached. Then set

$$M\ (t_1{:}\ T) = \max_{t_1 \le k \le T} \left(\frac{T - t_1 + 1}{2}\right)^{\frac{1}{2}} |D_k[t_1{:}T]| \quad (9)$$

If $M(t_1{:}T) > C_{0.05}$, then $k^*(X[t_1{:}T])$ can be considered a structural break point; if $M(t_1{:}T) < C_{0.05}$, then variance in the series does not change.

Patricia and Nikolaos (2009) observed that the ICSS method can identify periods of high and low exchange volatility. Lin (2011) and Charfeddine et al. (2011) found that long memory behavior is spurious and causes breaks in data.

(4) GARCH Model Estimations with Changes in Variance

Lamoureux and Lastrapes (1990) and Glosten et al. (1993) combined GARCH and dummy variables to represent various changes in variance. The GARCH model modified by Arago and Fernandez (2003) accounts for detected changes in unconditional variance.

$$h_t^2 = \alpha + \sum_{i=2}^{p} F_i D_i + \sum_{i=1}^{p} \beta_i h_{t-i}^2 + \sum_{i=1}^{q} \delta_i \varepsilon_{t-i}^2 \quad (10)$$

$$h_t^2 = \alpha + \sum_{i=2}^{p} F_i D_i + \sum_{i=1}^{p} \beta_i h_{t-i}^2 + \sum_{i=1}^{q} \delta_i \varepsilon_{t-i}^2 + \gamma S_{t-1}^{-} \varepsilon_{t-1}^2 \quad (11)$$

Where D_i refers to dummy variables (breaks) that reflect changes in variance. The parameters that accompany these variables (F_i) reflect differences from α. S_{t-1} is equal to the unit if $\varepsilon_{t-1} < 0$ (innovation in $t = 1$) or to zero if $\varepsilon_{t-1} > 0$. The asymmetrical effect is captured if $\gamma > 0$. The effect on volatility depends on the sign of the innovation in $t-1$. Lamoureux and Lastrapes (1990) pointed out that great persistence occurs when GARCH models that disregard possible deterministic changes in unconditional variance are used.

3. Empirical Result

All the travel and tourism index returns have positive average returns and small standard deviations (Table 1). Skewness is important to finance and investment. Most of the data on DJI, except Dow Jones US Travel and Tourism (^DJUSTT) and FTSE, have negative skewness. All NZSE tourism indices have positive skewness. Most of the data, except FTSE XUK-TRAVEL & LEI (WIXUKS5750L), have a leptokurtic distribution. Kurtosis facilitates the identification of risk for the index. If historical return data yield a leptokurtic distribution, the index has a low quantity of variance because the returns are usually close to the mean. To avoid erratic swings in portfolio returns, investors may consider planning their investment to obtain a leptokurtic distribution. The significant Jarque-Berastatistic for residual normality shows that the travel and tourism indices are non-normally distributed. The Q correlation coefficient shows that all data samples have no serial correlation.

This study uses the minimum Akaike information criterion (AIC) to classify the orders of the ARFIMA and FIGARCH models and the Lagrange multiplier test (ARCH-LM) to test the ARCH effect. The null hypothesis for all samples is rejected, implying that we can apply the GARCH model to these data.

To test the unit root test, we use the augmented Dickey-Fuller test (Dickey & Fuller, 1979) to clarify whether the variable is stationary or non-stationary. The null hypothesis is rejected (Table 2), indicating that all variables are significantly stationary and appropriate for further testing. We use the minimum AIC value to identify the optimal ARMA model. Through the LM test, we observe whether the residuals have serial correlation. All the variables are not significant, suggesting that we can accept the null hypothesis of no autocorrelation and that all the variables are effective. To test the ARCH effect, we use ARCH-LM (Engle, 1982). The ARCH effect occurs if ARCH-LM significantly rejects the null hypothesis.

All the data are significant and reject H_0, implying that the regression is effective. Engle (1982) proposed the GARCH model to describe the variance of residual change over time. After the GARCH model is identified, an ARCH-LM test can be used to identify whether variables have the ARCH effect. All the variables in this study are non significant, implying no ARCH effect.

Table 1 The Descriptive Statistics of Variables

Market	Index	Inception Period	Obs.	Mean	Std. Dev.	Skew.	Kurt.	J-Bera	Q(10)
NZSE	Leisure & Tourism Capital (^NZLT)	2000/01/06	3158	0.0002	0.0129	1.0872	18.2390	44396***	13.2056 (0.2124)
	Leisure & Tourism Gross (^NZLTG)	2000/01/06	3158	0.0004	0.0128	1.1246	18.6790	46578***	16.4616 (0.0872]
DJI	Dow Jones Asia Pacific Travel & (^P1CGS)	2002/3/1	2637	0.0002	0.0108	-0.2544	4.5067	2260.1***	9.67902 (0.4691]
	Dow Jones U.S. Travel & Leisure (^DJUSCG)	2001/12/26	2643	0.0004	0.0151	-0.0221	3.6992	1507.2***	14.5785 (0.1482]
	Dow Jones U.S. Travel & Tourism (^DJUSTT)	2004/12/21	1863	0.0008	0.0230	0.1458	3.9695	1229.8***	16.3893 (0.0891]
	STOXX Americas 600 Travel & Leisure (^SXA1CGS)	2003/11/12	1706	0.0004	0.0144	-0.0252	4.1252	1209.8***	15.0806 (0.1291]
FTSE	FTSE XUK-Travel & Leisure (WIXUKS5750.L)	2004/4/19	1988	0.0003	0.0102	-0.0991	2.3688	468.06***	15.0430 (0.1305)
	FTSEuro Euro Travel (EB5700.L)	2004/9/22	1837	0.0004	0.0167	-0.1427	6.5191	3259.2***	16.3651 (0.0896]

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

Sources: Yahoo Finance- Various Inception date up to 13 July 2012.

Table 2 Summary Statistics of Unit Root, ARMA, LM, ARCH-LM and GARCH

Market	Index	ADF	ARMA	AIC	LM	ARCH-LM	GARCH	AIC	ARCH-LM
NZSE	Leisure & Tourism Capital (^NZLT)	-54.3245***	(2,3)	-5.8607	1.0415	6.7861***	(3,2)	-5.9770	0.5240
	Leisure & Tourism Gross (^NZLTG)	-54.5573***	(3,3)	-5.876	0.1939	6.8388***	(3,1)	-5.9922	0.0006
DJI	Dow Jones Asia Pacific Travel (^P1CGS)	-50.8060***	(3,3)	-6.2251	2.0953	29.9956***	(3,1)	-6.3786	2.3963
	Dow Jones U.S. Travel & Leisure (^DJUSCG)	-52.5160***	(3,3)	-5.5514	0.5827	145.7823***	(2,2)	-5.9425	0.0000
	Dow Jones U.S. Travel & Tourism (^DJUSTT)	-44.3249***	(1,1)	-4.7163	0.9037	36.4981***	(2,3)	-5.0884	0.0028
	STOXX Americas 600 Travel & Leisure (^SXA1CGS)	-31.7647***	(3,3)	-5.6546	1.2690	74.4540***	(3,3)	-6.0707	0.3779
FTSE	FTSE XUK-Travel & Leisure (WIXUKS5750.L)	-42.8314***	(3,2)	-6.3459	3.0672	29.6887***	(3,3)	-6.5014	0.5415
	FTSEuro Euro Travel (EB5700.L)	-5.3401***	(3,2)	-5.3435	0.8775	18.9595***	(3,2)	-5.5788	0.0003

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

Table 3 presents the results of the ARFIMA and ARFIMA-FIGARCH models. We test ARFIMA (0, d, 1) to ARFIMA (3,d,3) on the basis of the minimum AIC to obtain the optimum model and measure d to estimate the existence of long memory. The d coefficients of all the variables are below 0.5, revealing that the time series variable is stationary. Intermediate memory exists because the d coefficient is $-0.5 < d < 0$. The return index of Dow Jones Asia Pacific Travel (^P1CGS) cannot be represented by any autoregressive process because it exhibits a non-invertible stationary process, whereas ^DJUSTT shows a long memory process. These findings are consistent with those of Nouira et al. (2004), Kang and Yoon (2007), Floros et al. (2007), Choi and Hammoudeh (2009), Tan and Khan (2010), and Chen and Diaz (2013), indicating that ^DJUSTT can be predicted.

Table 4 illustrates the effect of multiple structural breaks. Perron (1989) found two structural breaks. The first was in 1929during the Great Depression, and the second was the oil price crisis in 1973. The current study uses ICSS to measure sudden series changes to the unconditional volatility. The ICSS method detects multiple structural breaks. If the value is larger than 1.358, a structural break has occurred. Empirical results reveal that most of the variables have multiple structural breaks. Leisure and Tourism Capital (^NZLT), Leisure and Tourism Gross (^NZLTG), and Dow Jones US Travel and Leisure (^DJUSCG have structural breaks on 15 June 2001 because of the effect of recession caused by unreasonable excitement regarding high technology. In 1999, the year 2000 (Y2K) shock caused an economic explosion in computer and software sales. Many companies and individuals bought new computer systems to ensure that their software was Y2K compliant. The high stock price of many high-technology companies increased the money flow of investors to these companies. The excitement regarding dot-com companies became unreasonable. Moreover, high interest rates caused a recession because they not only restricted liquidity but also reduced the amount of money to invest. Despite the stock market decline in March 2000, the Federal Reserve persistently raised interest rates to a high level of 6.25% in May 2000 and thus damaged the low rates for cheap business loans and mortgages.

Table 3 Summary Statistics of ARFIMA and ARFIMA-FIGARCH Models with All Period

Market	Index	ARFIMA			ARFIMA-FIGARCH				
		model	d-coeff.	AIC	ARCH-LM	d-coeff.	model	d-coeff.	AIC
NZSE	Leisure & Tourism Capital (^NZLT)	3,3	-0.0412 (0.312)	-5.8610	3.0493 *** (0.0095)	0.0399 ** (0.0572)	2,1	0.6257* (0.0865)	-5.9745
	Leisure & Tourism Gross (^NZLTG)	3,2	-0.0159 (0.495)	-5.8749	3.3770*** (0.0048)	-0.0325 (0.2710)	2,2	0.7033*** (0.0020)	-5.9940
DJI	Dow Jones Asia Pacific Travel (^P1CGS)	2,3	-0.0385* (0.100)	-6.2176	96.503*** (0.0000)	-0.0510 (0.4843)	3,2	0.3624*** (0.0000)	-6.3717
	Dow Jones U.S. Travel & Leisure (^DJUSCG)	3,3	0.0154 (0.786)	-5.5485	131.75 *** (0.0000)	0.0652 (0.8197)	3,2	0.8101*** (0.0000)	-5.9437
	Dow Jones U.S. Travel & Tourism (^DJUSTT)	2,2	0.1489*** (0.033)	-4.7154	58.913*** (0.0000)	0.0554 (0.3697)	1,2	1.2006*** (0.0000)	-5.0844
	STOXX Americas 600 Travel & Leisure (^SXA1CGS)	2,2	-0.0308 (0.128)	-5.6545	82.723 *** (0.0000)	-0.0141 (0.6251)	3,2	0.7623*** (0.0000)	-6.0660
FTSE	FTSE XUK-Travel & Leisure (WIXUKS5750.L)	3,2	-0.0461 (0.210)	-6.3410	26.202*** (0.0000)	-0.0244 (0.5400)	2,1	0.6218*** (0.0008)	-6.4901
	FTSEuro Euro Travel (EB5700.L)	2,3	-0.0340 (0.322)	-5.3415	14.385 *** (0.0000)	0.1926 (0.6365)	2,2	0.3332*** (0.0000)	-5.5684

Note: *, ** and *** are significance at 10, 5 and 1% levels, respectively; p-values are in parentheses.

On 25 July 2007, ^NZLT, ^NZLTG, and ^DJUSCG had the same structural breaks, which were caused by the economic crisis in 2008. The price of oil almost tripled from $50 to $147 from 2007 to 2008 before falling as the financial crisis began in late 2008, influencing transportation expenses, including tourism expenses. The bursting of the housing bubble was followed by a rapid increase in commodity prices. Irrational excitement in the housing market led many people to buy houses that they could not afford. In 2006, the bubble burst as housing prices declined. This situation caught many homeowners off guard, who had obtained loans with little money. During that time, if homeowners sold their houses at a price lower than their mortgages, they lost a huge amount of money. This condition caused panic among many banks and hedge fundsandled to the $700 billion bailout, bankruptcy, or government nationalization of Bear Stearns, the American International Group, Fannie Mae, Freddie Mac, IndyMac Bank, and Washington Mutual. In December 2008, employment declined more rapidly than that in 2001. Economic recessions are caused by slow GDP growth, which is due to a reduced speed in manufacturing orders, declining housing prices and sales, and falling business investment. This slow growth decreased employment and increased unemploymentand thus reduced retail sales, leading to a continuous downward trend in manufacturing and an increase in layoffs.

Table 4 demonstrates that the structural breaks for ^NZLT, ^NZLTG, and ^DJUSCG all happened on 13 February 2012 because oil prices were high then. Oil prices started to increase substantially early in 2012 compared with those in the previous year. On 13 February 2012, the prices of West Texas Intermediate crude oil were higher than $100 a barrel. In the same week, the rising oil prices also drove gas prices higher than $3.50 a gallon. In January, gas prices surpassed the $3.50 a gallon on the East and West coasts. People were worried because gas and oil pricesrose earlier than they did in the previous period.

Table 4 The Result of Structural Breaks

Market	Variables	Change Points	Interval	$\max_k\left(\left(\frac{T}{2}\right)\|D_k\|\right)^{\frac{1}{2}}$
NZSE	Leisure & Tourism Capital (^NZLT)	2007/6/15	2000/01/06-2012/7/13	17.6057
	P1	2001/6/15	2000/01/06-2001/9/28	6.9837
	P2	2007/7/25	2001/10/1-2009/4/7	22.5917
	P3	2012/2/13	2007/6/19-2012/7/13	30.8462
	Leisure & Tourism Gross (^NZLTG)	2007/7/25	2000/01/06-2012/7/13	17.8586
	P1	2001/6/15	2000/1/6-2001/10/19	7.5321
	P2	2007/7/26	2001/10/22-2009/3/20	22.8385
	P3	2012/2/13	2009/3/23-2012/7/13	34.1841
DJI	Dow Jones Asia Pacific Travel (^P1CGS)	2004/6/15	2002/3/1-2012/7/13	13.1091
	P1	2004/6/7	2002/3/1-2008/8/18	13.1068
	P2	2012/6/27	2008/8/19-2012/7/13	28.6978
	Dow Jones U.S. Travel & Leisure (^DJUSCG)	2007/6/15	2001/12/26-2012/7/13	17.6410
	P1	2001/6/15	2000/1/6-2001/9/17	6.6032
	P2	2007/7/25	2001/9/18-2009/4/3	22.4432
	P3	2012/2/13	2009/4/6-2012/7/13	34.2630
	Dow Jones U.S. Travel & Tourism (^DJUSTT)	2008/1/3	2004/12/21-2012/7/13	15.8160
	P1	2008/1/3	2004/12/21-2010/5/18	29.4953
	P2	2011/7/28	2009/3/12-2011/10/3	23.1546
	P3	2011/10/5	2011/10/4-2012/7/20	29.0222
	STOXX Americas 600 Travel & Leisure (^SXA1CGS)	2008/1/1	2003/11/12-2012/7/13	17.6755
	P1	2008/1/1	2003/11/12-2009/4/2	17.6816
	P2	2009/12/15	2009/4/3-2009/12/15	26.1056
	P3	2010/4/26	2009/12/15-2012/7/13	28.2705
FTSE	FTSE XUK-Travel & Leisure (WIXUKS5750.L)	2008/1/3	2004/4/19-2012/7/13	11.5717
	P1	2008/1/3	2004/4/19-2008/11/20	11.5404
	P2	2008/12/2	2008/11/21-2011/7/18	23.1887
	P3	2011/7/29	2011/7/19-2012/7/13	29.4953
	FTSEuro Euro Travel (EB5700.L)	2007/11/6	2004/9/22-2012/7/13	14.1149
	P1	2007/11/6	2004/9/22-2009/3/9	14.1010
	P2	2009/12/15	2009/3/10-2009/12/15	22.2711
	P3	2010/4/21	2009/12/16-2010/8/3	24.7803
	P4	2011/7/29	2010/8/4-2011/10/17	26.7234
	P5	2011/10/19	2011/10/18-2012/7/13	28.7566

Source: Organized by the Authors.

Likewise, ^DJUSTT, FTSE Xuk-Travel and Leisure, and FTSE Euro Travel had similar structural breaks from 28 to 29 July 2011 because the US economy grew by 1.3% in the second quarter of 2011, according to the GDP estimate of the Bureau of Economic Analysis. This estimate was significantly better than the revised 0.4% growth in the first quarter. This news affects the travel and tourism index of the US and Europe.

^DJUSTT, STOXX Americas 600 Travel and Leisure, and FTSE Xuk-Travel and Leisure had structural breaks on 3 January 2008, during the subprime mortgage crisis. The subprime mortgage crisis significantly affected the global market. This situation influenced tourism activities; many people did not have much money to travel and thus affected the travel and tourism indices.

Dow Jones Asia Pacific Travel had a structural break on 27 June 2012. According to Asia-Pacific Business Traveler Research 2012, the average executive took 10 trips in the first half of 2012 as opposed to six trips in 2011.

This study uses the GARCH model with the dummy variable *F* determined by the value of the ICSS method. If the value is larger than the criterion value of 1.358, *F* is equal to one. Otherwise, *F* is equal to zero. The variable $F_i$reflects the differences from the variance of F_1 in the study period. This study also uses *r* to test the asymmetrical effect. If *r* is significant and positive for selecting the desired fitting model according to the AIC, the asymmetrical effect exists.

Table 5 shows the effect of structural breaks on the tourism and travel indices. For example, the estimated coefficient of F_1 for Leisure and Tourism Capital is significant, and the estimated value is 0.94742, confirming an increase in the unconditional variance for Leisure and Tourism Capital. In Leisure and Tourism Capital, the estimated value F_3 is a significant −0.0001, confirming a decrease over the value of the unconditional variance obtained for F_3 in the third sub-period.

All the tourism and travel index coefficients of F_1arepositive and significant, suggesting an increase in the unconditional variance obtained for all tourism and travel indices from New Zealand, the US, and Europe.

Arago and Fernandez (2003) pointed out that the predictable value of the fifth subperiod was 3.51, indicating an increase over the unconditional variance obtained for the first subperiod in the Spanish stock market. The resulting coefficient r is positive and significant, except those for ^DJUSTT and STOXX Americas 600 Travel and Leisure. The asymmetrical effect exists, and almost all indices are positive and significant.

Table 6 summarizes the long memory test. The tourism and travel indices of the New Zealand and European markets have an intermediate memory, whereas those of the US market have a long memory. The structural break test shows that all markets in New Zealand, Europe, and the US have structural breaks and several such breaks occurred on the same dates in 2007 and 2008. Those situations occurred because of the oil price increase and the economic crisis in 2007. Melvin and Taylor (2009) mentioned that the financial crisis that began in 2007 has caused the greatest financial difficulty since the Great Depression of the 1930s. Similar to most industries, the hospitality and tourism sector entails extra challenges because of the worldwide economic crisis. The declining capital market and decreased spending by both corporate and individual consumers ultimately affect the tourism business. For example, the subprime mortgage crisis in 2008 has significantly affected tourism and travel indices.

Table 5 The Effect of Structural Breaks with Whole Period

Market	Variables	GARCH	AIC	F & R
NZSE	Leisure & Tourism Capital (^NZLT)	(2,3)	-5.9808	F_1 = 0.9474(0.000***)
				F_2 = -0.0001(0.5973)
				F_3 = -0.0001(0.1879)
				r = 0.0538(0.000***)
	Leisure & Tourism Gross (^NZLTG)	(3,3)	-5.9975	F_1 = 0.9446(0.000***)
				F_2 = 0.0001(0.3949)
				F_3 = 0.0001(0.9872)
				r = 0.0602(0.000***)
DJI	Dow Jones Asia Pacific Travel (^P1CGS)	(3,3)	-6.3741	F_1 = 0.8695(0.000***)
				F_2 = -0.0001(0.2302)
				r = 0.0394(0.0099***)
	Dow Jones U.S. Travel & Leisure (^DJUSCG)	(3,3)	-5.9787	F_1 = 0.9344(0.000***)
				F_2 = -0.0001(0.9916)
				F_3 = -0.0001(0.7604)
				r = 0.0572(0.000***)
	Dow Jones U.S. Travel & Tourism (^DJUSTT)	(1,1)	-5.0829	F_1 = 0.9351(0.000***)
				F_2 = 0.0001(0.3948)
				F_3 = 0.0001(0.7217)
				r = 0.0141(0.3093)
	STOXX Americas 600 Travel & Leisure (^SXA1CGS)	(3,3)	-6.0559	F_1 = 0.9182(0.000***)
				F_2 = -0.0001(0.8655)
				F_3 = 0.0001(0.3227)
				r = 0.0178(0.238)
FTSE	FTSE XUK-Travel & Leisure (WIXUKS5750.L)	(3,2)	-5.7223	F_1 = 0.9312(0.000***)
				F_2 = 0.0001(0.2782)
				F_3 = 0.0001(0.3289)
				r = 0.0302(0.019**)
	FTSEuro Euro Travel (EB5700.L)	(3,2)	-5.5666	F_1 = 0.9137(0.000***)
				F_2 = 0.0001(0.2932)
				F_3 = 0.0001(0.652)
				F_4 = 0.0001(0.362)
				F_5 = 0.0001(0.188)
				r = 0.0539(0.0001***)

Source: Organized by the Authors.

Table 6 The Result of Testing Long Memory and Structural Break Test

Long memory effect			
Index	NZSE	DJI	FTSE
Leisure & Tourism Capital (^NZLT)	intermediate long memory		
Leisure & Tourism Gross (^NZLTG)	intermediate long memory		
Dow Jones Asia Pacific Travel (^P1CGS)		intermediate long memory	
Dow Jones U.S. Travel & Leisure (^DJUSCG)		intermediate long memory	
Dow Jones U.S. Travel & Tourism (^DJUSTT)		long memory	
STOXX Americas 600 Travel & Leisure (^SXA1CGS)		intermediate long memory	
FTSE Xuk-Travel & Leisure (WIXUKS5750.L)			intermediate long memory
FTSEuro Euro Travel (EB5700.L)			intermediate long memory
Structural break test			
Index	NZSE	DJI	FTSE
Leisure & Tourism Capital (^NZLT)	2007/6/15		
Leisure & Tourism Gross (^NZLTG)	2007/7/25		
Dow Jones Asia Pacific Travel (^P1CGS)		2004/6/15	
Dow Jones U.S. Travel & Leisure (^DJUSCG)		2007/6/15	
Dow Jones U.S. Travel & Tourism (^DJUSTT)		2008/1/3	
STOXX Americas 600 Travel & Leisure (^SXA1CGS)		2008/1/1	
FTSE Xuk-Travel & Leisure (WIXUKS5750.L)			2008/1/3
FTSEuro Euro Travel (EB5700.L)			2007/11/6

Source: Organized by the Authors.

4. Conclusion

The empirical result presents several findings. First, most of the variables have intermediate memory, whereas several show long memory. Investors can observe historical data and identify changes in the market condition, especially for tourism and travel activities. Second, we discovered that most of the variables have structural breaks at different markets on the same date. For example, Leisure and Tourism Capital and Leisure and Tourism Gross trade at the New Zealand Stock Exchange have the same structural breaks with the ^DJUSCG trade at DJI. Therefore, the recession in 2001, the financial crisis in 2007, and the oil price crisis in 2012 have significantly affected the global market.

Third, New Zealand and Europe have a strong asymmetrical effect, but only Dow Jones Asia Pacific Travel and ^DJUSCG have a strong asymmetrical effect in the US. The New Zealand and European markets are unstable compared with the US market, and investors must be cautious in investing in the New Zealand and European markets, especially for tourism and travel indices.

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