18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009
http://mssanz.org.au/modsim09

Forecasting tourist accommodation demand in New Zealand

Lim, C. [1] **and F. Chan** [2]

[1] Department of Tourism & Hospitality Management, and Department of Finance, University of Waikato, New Zealand
[2] School of Economics and Finance, Curtin University of Technology, Australia
email: clim@waikato.ac.nz

Abstract: Tourism accounts for about 9% of New Zealand's Gross Domestic Product, 10% of employment and 18% of export earnings in 2007 (Ministry of Tourism, 2008a). The industry is New Zealand's largest export earner and its major tourist source markets include Australia, UK, USA, Japan and China. International and domestic tourists in New Zealand use a range of accommodation in their travel, from private homes to commercial and other accommodation. Tourist accommodation types are classified under the following five categories: hotels (include resorts), motels (motor inns, apartments and motels), hosted (private hotels, guesthouses, bed and breakfast and farm stays), backpackers/hostels, and caravan parks/camping grounds (Ministry of Tourism, 2008b). Figure 1 shows that tourist accommodation available from 1997 to 2007 is predominantly hotels and motels.

Seasonality has attracted considerable interest in empirical tourism research and forecasting. However, the analysis of such recurring phenomenon is sparse in hospitality research, with only one study to date having analysed seasonal unit roots prior to forecasting guest nights for the tourist lodging industry. This paper examines the seasonality of hotel-motel occupancy in New Zealand using monthly time series from 1997 to 2007. The presence of seasonal unit roots is detected using the HEGY procedures. Numerous Box-Jenkins models are estimated and the twelve differenced SARMA(2,2)(0,2)$_{12}$ is the optimal model selected to forecast hotel-motel room nights.

Keywords: *Seasonality, nonstationarity, unit roots, HEGY procedures, forecasting hotel-motel room nights*

1. INTRODUCTION

International tourism accounted for about 18% of New Zealand's total export earnings in 2007. The composition of inbound tourists to New Zealand by region is shown in Table 1. Oceania accounted for about 44% of tourists to New Zealand in 2007, of which about 39% of the international visitors were from Australia (see Table 2). The dominant market in the European region is the UK, which is New Zealand most important long haul market since 2000, followed by the USA. The New Zealand Government spent $5 million in marketing expenditure on US television advertisements on CNN, Discovery Channel and Public Broadcasting in 2005 to sustain tourism flows from this country. Most US tourists stayed between 4-6 days duration in 2005. The proportion of tourism flows from Asia has declined since the new millennium. Japan and China are the two most important Asian markets for New Zealand. Tourist arrivals from Japan, New Zealand fourth largest source market, have been declining since 1990 and it is superseded by China in 2008. The five major tourist destinations in New Zealand include Auckland, Rotorua, Wellington, Christchurch and Queenstown (see Figure 1)

Table 1. Total Visitor Arrivals to New Zealand by Region (%), 1990-2008

Region	1990	1995	2000	2005	2007
Oceania	40.5	33.3	37.2	41.6	43.7
Asia	19.1	31.9	24.2	22.0	20.5
Europe	17.4	18.1	20.5	21.7	20.8
Americas	18.4	13.5	13.7	11.7	11.8
Africa & Middle East	0.8	1.3	1.7	1.6	1.7

Source: Statistics New Zealand

Table 2. Top Five Tourist Source Markets (%), 1990-2008

Region	1990	1995	2000	2005	2007
Australia	35.0	28.6	32.1	37.0	38.7
UK	8.9	8.7	11.2	13.0	11.9
USA	14.3	10.8	11.0	9.1	8.8
Japan	11.0	10.8	8.5	6.5	5.0
China	0.3	0.6	1.9	3.7	4.9

Source: Statistics New Zealand

Figure 1. Top five tourist destinations in New Zealand

Seasonal fluctuations are an important source of variation in tourism and hospitality demand patterns, as measured by variables such as tourist arrivals at a destination or guest arrivals in the lodging industry. As shown in Figure 2, the monthly hotel and motel room night series in New Zealand from 1997 to 2007 trended upwards with seasonality. The seasonality phenomenon usually stems from natural (related to climate, weather, temperature) and/or institutional factors (related to school vacations, religious festivals, social customs/practices, other national celebrations and special events). Forecasts generated by time series models are often used as inputs for planning, policy-making, purchasing decision, inventory control, revenue maximization and other business decision-making activities in the tourism and hospitality industry (Chu, 1998; Kim, 1999; Kulendran and King, 1997; Lim and McAleer, 2002; Rajopadhye et al., 2001; Upchurch et al., 2002).

In this paper, we will focus on the Box and Jenkins (1970) approach to seasonal time series modelling, and pre-testing for seasonal unit roots using the Hylleberg, Engel, Granger and Yoo (1990) (HEGY) procedures. We will apply these techniques to examine and forecast tourist accommodation demand in New Zealand using hotel-motel room nights. The rest of the paper is organised as follows. The methodology and unit root tests for the hotel-motel room night time series data are discussed in Sections 2 and 3, respectively. The estimation results and some concluding remarks are given in Section 4. The EViews 5 econometric software package is used for the data analysis and empirical estimation.

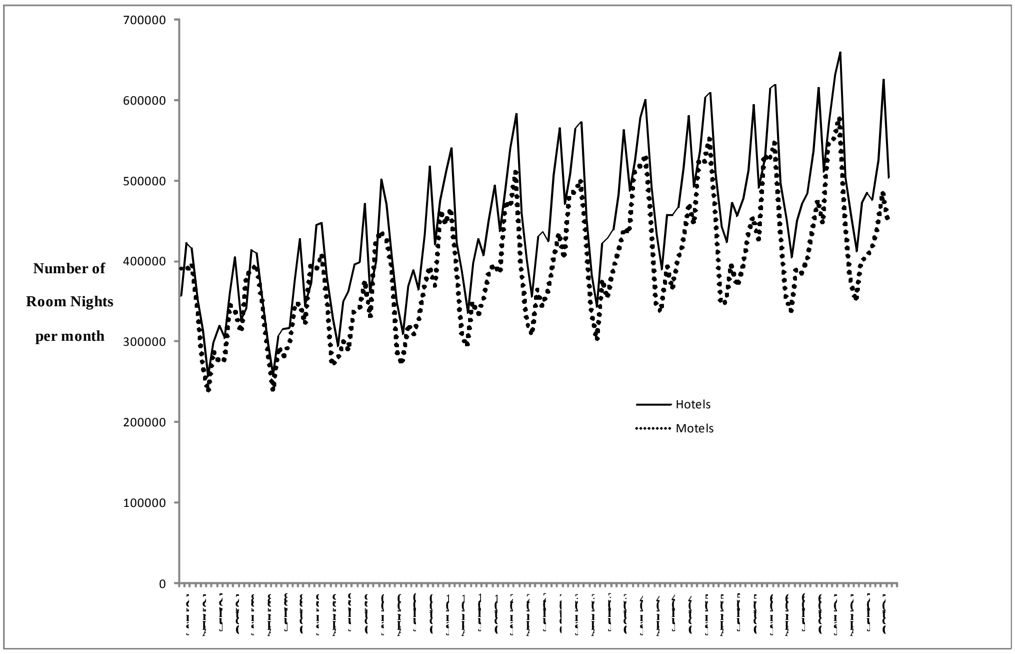

Figure 2. Monthly hotel and motel room nights occupied in New Zealand, 1997-2007

2. METHODOLOGY

The Box-Jenkins autoregressive (AR) and moving average (MA) or ARMA process is represented by:

$$A_t = c + \alpha_1 A_{t-1} + \ldots + \alpha_p A_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \ldots + \beta_q \varepsilon_{t-q}$$

where $A_t, A_{t-1}, \ldots, A_{t-p}$ are the current and past numbers of room nights. The ε_t which represent current and past values of random errors, are assumed to be identically and independently normal, with mean zero and constant variance.

Since seasonality is a dominant feature in tourism demand, the Box-Jenkins seasonal model or SARIMA $(p,d,q)(P,D,Q)_S$ with D seasonal differences, is more appropriate:

$$(1-\varphi_1 L-\ldots-\varphi_p L^p)(1-\Phi_1 L^s-\ldots-\Phi_P L^{P\,s})[w_t-\mu]=(1-\theta_1 L-\ldots-\theta_q L^q)(1-\Theta_1 L^s-\ldots-\Theta_Q L^{Q\,s})\varepsilon_t$$

where Φ and Θ = fixed seasonal AR and MA parameters, respectively,

s = number of seasons or periods in a year.

$w_t = (1-L)^d (1-L^s)^D y_t$ is the filtered series and $\mu = E(w_t)$

The seasonal component of the SARIMA $(p,d,q)(P,D,Q)_S$ model has its own AR and MA parameters of orders P and Q, respectively, while the non-seasonal components have associated parameters of orders p and q, respectively.

3. UNIT ROOT TESTS

Monthly hotel-motel room nights occupied are tested for unit roots using the Phillips-Perron (1988) (PP) procedure based on estimating the following regression equation by OLS:

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \varepsilon_t \,, \qquad (1)$$

where Δy_t is the change in the total monthly hotel and motel room nights at time t, t is a deterministic time trend, and ε_t is a stationary independent and identically distributed random variable. The PP procedure tests for:

$H_0: \delta = 0$

$H_1: \delta < 0$.

The PP statistic for y_t is -4.98 which is less than the 5% critical value of -3.44 and the trend coefficient is statistically significant at the 5% level. This implies y_t follows a trend stationary process. However, the monthly hotel-motel room night series displays pronounced seasonality as shown in Figure 3. Hence, we need to test for the presence of seasonal unit roots. The latter proposed by Hylleberg et al (1990) using quarterly data, has been extended to the monthly case by Beaulieu and Miron (1993), Franses (1991) and Franses and Hobijn (1997), which is based on the following regression equation:

$$\begin{aligned}\Delta_{12} y_t = \mu &+ \pi_1 y_{1,\,t-1} + \pi_2 y_{2,\,t-1} + \pi_3 y_{3,\,t-1} + \pi_4 y_{3,\,t-2} + \pi_5 y_{4,\,t-1} + \pi_6 y_{4,\,t-2} \\ &+ \pi_7 y_{5,\,t-1} + \pi_8 y_{5,\,t-2} + \pi_9 y_{6,\,t-1} + \pi_{10} y_{6,\,t-2} + \pi_{11} y_{7,\,t-1} + \pi_{12} y_{7,\,t-2} + \varepsilon_t \end{aligned} \qquad (2)$$

where

$y_{1,\,t} = (1+L)(1+L^2)(1+L^4+L^8)y_t$;

$y_{2,\,t} = -(1-L)(1+L^2)(1+L^4+L^8)y_t$;

$y_{3,\,t} = -(1-L^2)(1+L^4+L^8)y_t$;

$y_{4,\,t} = -(1-L^4)(1-L\sqrt{3}+L^2)(1+L^2+L^4)y_t$;

$y_{5,\,t} = -(1-L^4)(1+L\sqrt{3}+L^2)(1+L^2+L^4)y_t$;

$y_{6,\,t} = -(1-L^4)(1-L^2+L^4)(1-L+L^2)y_t$;

$y_{7,\,t} = -(1-L^4)(1-L^2+L^4)(1+L+L^2)y_t$

and ε_t is a normally and independently distributed error term with zero mean and constant variance.

Deterministic components which include an intercept, eleven seasonal dummies and a time trend can also be included in equation (2). The null and alternative hypotheses to be tested are as follows:

1) H_0: $\pi_1 = 0$, H_1: $\pi_1 < 0$;

2) H_0: $\pi_2 = 0$, H_1: $\pi_2 < 0$;

3) H_0: $\pi_3 = \pi_4 = 0$, H_1: $\pi_3 \neq 0$ and/or $\pi_4 \neq 0$.

4) H_0: $\pi_5 = \pi_6 = 0$, H_1: $\pi_5 \neq 0$ and/or $\pi_6 \neq 0$.

5) H_0: π_7=π_8=0, H_1: $\pi_7 \neq 0$ and/or $\pi_8 \neq 0$.

6) H_0: π_9=π_{10}=0, H_1: $\pi_9 \neq 0$ and/or $\pi_{10} \neq 0$.

7) H_0: π_{11}=π_{12}=0, H_1: $\pi_{11} \neq 0$ and/or $\pi_{12} \neq 0$.

The HEGY test involves the use of the t-test for the statistical significance of π_1 and π_2 (hypothesis (1) and (2) as outlined above), and the F-tests for $\{\pi_3 , \pi_4\}$, $\{\pi_5 , \pi_6\}$, $\{\pi_7 , \pi_8\}$, $\{\pi_9 , \pi_{10}\}$ and $\{\pi_{11} , \pi_{12}\}$ where $\{\pi_i ,\pi_j\}$ denotes the null hypothesis H_0:π_i=0, π_j=0 i, j=3,...,12, $i \neq j$.

The results are compared with the 5% critical values provided by Franses and Hobijn (1997) using 10 year observations. As the estimated values are greater than the critical values, the first and fifth hypotheses are rejected at the 5% level of significance, but the other five null hypotheses cannot be rejected. While non-seasonal unit root appears to be absent in the monthly hotel-motel room night series, we argue that the series has seasonal unit roots based on the estimated F-statistic for $\{\pi_2 , ..., \pi_{12}\}$. Diagnostic checking using the Q-statistic and Lagrange multiplier test indicate there is no serial correlation in the residuals.

4. DISCUSSION AND CONCLUSIONS

The results from the HEGY test suggests that d=0 and D=1. Different combinations of AR, MA, SAR and SMA models with values for p, q, P and/or $Q \leq 2$, and a constant are estimated for the SARMA models. A preference for parsimonious models means that only those with all significant parameter estimates at the 5% level and with no serial correlation are selected. The process of identification, estimation and diagnostic checking have resulted in the selection of SARMA(2,2)(0,2)$_{12}$ as the optimal model to generate forecasts for hotel-motel room nights in New Zealand (see Table 3).

Table 3. Estimates of Selected SARMA Model for Hotel-Motel Room Nights, 1997(1)-2007(12)

Variable	Coefficient	t-statistic	AIC/SBC
Constant	33336.41	5.76	AIC = 23.28
AR(2)	0.578	4.01	SBC = 23.40
MA(1)	0.307	3.45	
MA(2)	-0.578	-4.62	
SMA(2)	0.341	2.96	

Note: AIC and SBC are the Akaike Information Criterion and Schwarz Bayesian Criterion, respectively.

Using the Breusch-Godfrey Lagrange multiplier or LM(SC) diagnostic checks, the residual of the model is found to be serially uncorrelated. Furthermore, the Jarque-Bera Lagrange multiplier or LM(N) statistic which tests whether the residuals are normally distributed, is significant at the 5% level and the null hypothesis of normality is not rejected for the model (see Table 4).

Table 4. Lagrange multiplier test for serial correlation and normality

Diagnostics	SARMA(2,0,2)(0,1,2)
$F_{LM(SC)}$	0.23 [0.79]
LM(N)	0.95 [0.62]

Note: $F_{LM(SC)}$ and LM(N) are the Lagrange multiplier test for serial correlation and the Jarque-Bera Lagrange multiplier test for normality, respectively. Figures in parentheses denote probability values.

The SARMA(2,0,2)(0,1,2) model is used to forecast hotel-motel room nights in New Zealand in 2007. As shown in Figure 3, the model does not perform well in the out-of-sample forecast.

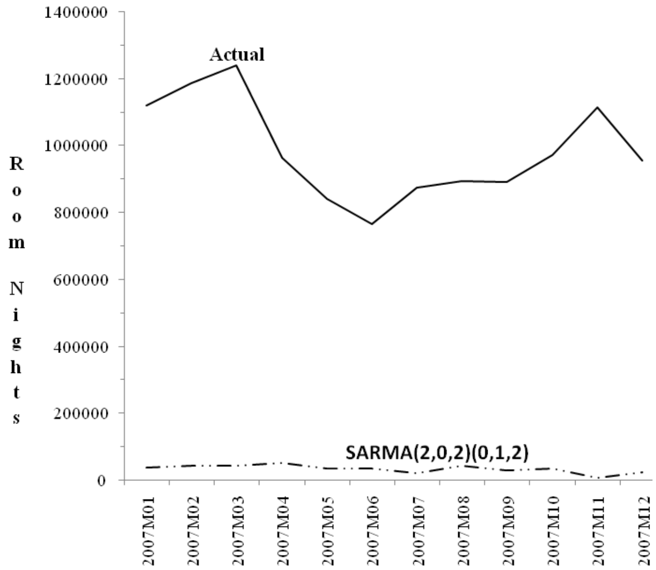

Figure 3. Estimated ex post hotel-motel room night forecasts, 2007

The aim of this paper is to analyse room occupancy in New Zealand's lodging industry using Box-Jenkins (1970) univariate time series modeling. In particular, the autoregressive moving average processes have been used to explain the seasonal patterns of hotel-motel room nights occupied. The Phillips-Perron unit root test and the HEGY test for the presence of seasonal and non-seasonal unit roots were applied to the room nights series. In this analysis, a series is transformed into a stationary series if necessary before it is identified, estimated and diagnosed.

One of the primary challenges facing the hospitality industry is to generate accurate forecasts of tourist accommodation demand to maximize revenue. The twelve differenced SARMA(2,0,2)(0,1,2) was the optimal model selected for short-term forecasting. But the forecast generated did not track the actual room nights occupied closely in 2007.

REFERENCES

Beaulieu, JJ and JA Miron (1993). Seasonal unit roots in aggregate US data. *Journal of Econometrics,* 55, 305-328.

Box, GEP and GM Jenkins (1970). *Time Series Analysis, Forecasting and Control*. San Francisco: Holden Day.

Chu, F.-L. (1998). Forecasting Tourist Arrivals. *Journal of Travel Research*, 36, 79-84.

Franses, PH (1991). Seasonality, nonstationarity and the forecasting of monthly time series. *International Journal of Forecasting,* 7, 199-209.

Franses, PH and B Hobijn (1997). Critical values for unit root tests in seasonal time series. *Journal of Applied Statistics,* 24(1), 25-47.

Hylleberg, S, Engle, RF, Granger, CWJ and BS Yoo (1990). Seasonal integration and cointegration. *Journal of Econometrics,* 44, 215-238.

Kim, J.H. (1999). Forecasting Monthly Tourist Departures from Australia. *Tourism Economics*, 5, 277-291.

Kulendran, N. & King M.L. (1997). Forecasting International Quarterly Tourist Flows using Error-Correction and Time-Series Models. *International Journal of Forecasting*, 13, 319-327.

Lim, C and M McAleer (2002). Time series forecasts of international travel demand for Australia. *Tourism Management*, 23(4), 389-396.

Ministry of Tourism (2008a). Key Tourism Statistics at http://www.trcnz.govt.nz, accessed 5 March 2009.

Ministry of Tourism (2008b). Accommodation sector at http://www.tourismresearch.govt.nz, accessed 5 March 2009.

Phillips, PCB and P Perron (1988). Testing for a unit root in time series regression. *Biometrika,* 75, 335-346.

Rajopadhye, M., Ghalia, M.B., Wang, P.P., Baker, T., Eister, C.V., 2001. Forecasting uncertain hotel room demand. Information Sciences 132, 1-11.

Statistics New Zealand (1997 to 2007). Accommodation Survey. Wellington.

Upchurch, R.S., Ellus, T., Seo, J., 2002. Revenue management underpinnings: An exploratory review. International Journal of Hospitality Management 21, 67-83.