

Forecasting RevPAR in a Declining Market: An Application of Time Series Forecasting Techniques to U.S. Weekly RevPAR Data

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ABSTRACT

This study utilizes common time series forecasting methods to determine which of several simple, popular time series forecasting techniques was the best predictor of the decline in United States weekly RevPAR as the lodging industry entered its severe downturn in 2009. This study identifies the strong seasonality and trend components contained in historic U.S. weekly RevPAR data and utilized that data to test various moving average, exponential, and seasonal forecasting methods. The study clearly identified that seasonal forecasting methods such as Holt-Winters are far superior for use with this dataset than other methods and that among the various seasonal forecasting methods that multiplicative forecasting methods are somewhat superior to additive forecasting methods in working with this dataset.

Keywords: RevPAR, time series, lodging industry, forecasting

INTRODUCTION

At the end of the second quarter of 2009, it became evident that the U.S. lodging industry would experience the worst year-over-year decline in performance since the 1930s (Woodworth & Walls, 2009). At that time, it was predicted that real revenue per available room (RevPAR) would decline over 25% from 2007 to 2010, a contraction matched only by the decline experienced in the Great Depression (Woodworth & Walls, 2009).

The purpose of this study is to determine which of several simple, popular time series forecasting techniques was the best predictor of the decline in United States weekly RevPAR as the lodging industry entered this recent severe downturn. Through an analysis of these methods, it is hoped that researchers and practitioners can become better prepared to react to future RevPAR volatility in both up and down markets.

LITERATURE REVIEW

Forecasting in the hospitality industry

Forecasting in the hotel industry is very useful for estimating or calculating a variety of factors that can assist management in strategic decision making. Brown & Dev (1999) identified forecasting as a way to improve a firm’s productivity. Other authors compare forecasting in the lodging industry with forecasting the weather with all the pitfalls it can carry (Smith & Lesure,

1996). Among the functions that can be estimated or determined using forecasting include customer mix, purchasing needs, inventory control, staff recruitment, and optimization of room revenue. Optimization is a component of yield management which involves determining what, when and to whom sell a room to generate more profits.

Andrew, Cranage, & Lee (1991) and Cranage (2003) have conducted various studies in the hospitality industry using time series models. Andrew, Cranage, & Lee (1991) examined Box-Jenkins and exponential smoothing time series forecast models for forecasting hotel occupancy rates. The study utilized a single major center-city hotel to forecast monthly occupancy with highly predictive results. Cranage (2003) tested various time series forecasting methods to forecast gross sales of a restaurant finding that the use of time series forecasting was appropriate for use at the restaurant unit level.

Time series background and theoretical underpinnings

A time series model requests the relevant measurement history from a set of data explained past and a random disturbance term, and also it demands to meet the need of particular attention in order to investigate the historic patterns and trends of time series studied and to forecast the future of their own trends and pattern (Brown, 1959; Holt, 1957; Lim et al., 2009; Song & Li, 2008; Winters, 1960). Time series models have been extensively conducted to fulfill the demand forecasting accuracy in the hotel and tourism industry as well as other industries.

There are three basic versions of exponential smoothing methods which are commonly used: 1) simple exponential smoothing (Brown, 1959), 2) trend-corrected exponential smoothing (Holt, 1957), and 3) Holt-Winters' method (Winters, 1960). The exponential smoothing forecast methods are more complicated than the simple moving average model and also these methods are powerful tools to forecast the future trends and patterns based on past data (Billah, King, Snyder, & Koehler, 2006). Weatherford and Kimes (2003) demonstrate the exponential smoothing and pickup methods are more accurate among seven different methods, but they recommend that three methods: moving average, Holt's, and linear regression are appropriate to forecast. In addition, they emphasize that exponential smoothing method is the most robust

Holt-Winters methods are divided into two types. The Holt-Winters Additive method is useful when the volume of the seasonal effects in the guest night sets does not adjust. On the other hand, the Holt-Winters Multiplicative method is appropriate when the size of the seasonal patterns is changed. Lim et al. (2009) compared Holt-Winters with Box-Jenkins methods in order to investigate which model could correctly predict the results of actual guest nights in 2007, using a set of data from 1997 to 2006 in the hotel and model business in New Zealand; both methods are well known as predictors of forecast. According to their findings, the Holt-Winters and the Box-Jenkins autoregressive moving average models (ARMA) are more appropriate to forecast demand of guest nights rather than other forecasting methods. Rajopadhye et al. (2001) only evaluated the Holt-Winters multiplicative method to forecast hotel room demand, assuming that the seasonal effects are proportional in dimensions to the local mean and that the cancellation ratio does not change for each year.

RESEARCH METHODOLOGY

The purpose of this study is to determine which of several simple, popular time series forecasting techniques was the best predictor of the decline in United States weekly RevPAR in the recent economic downturn. Weekly RevPAR data was selected as data is readily obtainable and is referenced in a variety of hotel industry and financial industry publications as a tracking mechanism for the health of the overall hotel market. Data was obtained from Smith Travel Research for weekly periods from January 2004 through September 2009 or a total of 299 observations.

Weekly RevPAR data was analyzed using Crystal Ball Predictor (CB Predictor) software which performs various time series analyses and computes measurable statistics which can be used to compare various forecasting methods. For this study, weekly RevPAR was analyzed from January 2004 through December 2008 (260 observations), with the period from January 2009 through September 2009 utilized as the comparison forecast period (39 observations).

This period was selected as it includes both a period of expansion as well as a period of recession as defined by the National Bureau of Economic Research (2010). During this period, U.S. weekly RevPAR ranged from \$28.08 in week 52 of 2004 to a high of \$80.29 in week 30 of 2007.

The dataset was analyzed using both seasonal and non-seasonal methods in order to better identify the benefits of each method. The methods utilized were single moving average, double moving average, single exponential smoothing, double exponential smoothing, seasonal additive, Holt-Winters additive, seasonal multiplicative, and Holt-Winters multiplicative. The additive and multiplicative models are decomposition models which are capable of capturing secular, cyclical, and seasonal trends by breaking the data down into the component trends along with an error component. Multiplicative decomposition models assume that there is interaction between variables while additive decomposition models do not. The formulas used for each of these techniques is included as Appendix A (EPM Information Development Team, 2010).

The adequacy of forecasting models can be assessed using a variety of techniques. This study assesses the adequacy of each forecasting model using mean absolute deviations (MAD), mean square error (MSE), and mean absolute percentage error (MAPE). Each of these techniques involves determining the sum of absolute forecast errors on either an absolute basis, (MAD), a squared basis (MSE), or as a percentage of actual basis (MAPE). In each case, the sum of the errors is divided by the number of observations. Lower results are considered to be better as they are indicative that the average error is less than the result obtained by other observations.

RESULTS AND DISCUSSION

The results of the analysis indicate overall that the seasonal models were far superior to the non-seasonal models. As indicated in Table 1, the lowest overall MAD, MSE, and MAPE values were obtained in the multiplicative seasonal models, with the Holt-Winters' multiplicative model providing the most accurate forecast. The MSEs ranged from 3.51 to 10.84, the MADs from 2.58 to 8.95, and the MAPEs from 4.22% to 15.32%. The Durbin-Watson statistic ranged from 0.46 to 1.83. It is noted that while comparable studies using this type of data have not been

performed, these results are very low when compared with unit-level forecasting studies done in the hospitality industry (Blecher & Yeh, 2008).

Table 1
Evaluation of Forecasting Models

Forecasting Model	MSE	MAD	MAPE	Theil's U	Durbin-Watson
Single Moving Average	9.46	7.49	12.82%	1.4873	0.4553
Double Moving Average	9.52	7.12	12.63%	1.6067	0.4662
Single Exponential Smoothing	10.84	8.95	15.32%	1.4301	0.4902
Double Exponential Smoothing	10.62	8.02	14.71%	1.5441	0.4461
Seasonal Additive	3.62	2.91	4.66%	0.4167	1.6637
Holt-Winters' Additive	3.60	2.88	4.63%	0.4168	1.6958
Seasonal Multiplicative	3.51	2.88	4.51%	0.4037	1.8228
Holt-Winters' Multiplicative	3.51	2.58	4.22%	0.4261	1.7605

It is very clear from the results that the moving average and exponential smoothing methods were not as accurate as seasonal methods. While this result would be expected based on the dramatic seasonal variance in the data, it is nonetheless an important finding. Within the seasonal forecasting methods, it is also clear that the multiplicative methods were more accurate than the additive methods. Again, this would be expected given the interaction between the long-term secular trend component, the cyclical trend component, and the seasonal trend component. By accounting for these interactions in a multiplicative manner, a more accurate forecast is achieved.

LIMITATIONS AND CONCLUSIONS

This study is important in that it supports prior studies which have identified the use of seasonal time series forecasting methods as a potent predictor of seasonal data in the hospitality industry. This study is the first study to utilize U.S. weekly RevPAR data in its analysis and shows strong support for the use of time series analysis for further study of this dataset and, as a result, can be of benefit to both researchers as well as industry practitioners including lodging company executives and stock market analysts.

This study was limited to the size of the dataset obtained and it is noted that the dataset utilized primarily contained data from a generally rising market from 2004 to 2008. Weekly RevPAR data for additional years could be obtained and data from other periods of economic decline might provide a more robust forecasting model. The authors elected to limit this study to very simple time series measures which are readily accessible and future researchers may wish to extend this work using more complex ARIMA methods or neural networks which may provide even better forecasts than multiplicative methods.

In conclusion, this study has identified the strong seasonality trends contained in historic U.S. weekly RevPAR data and utilized that data to test various moving average, exponential, and seasonal forecasting methods. The study clearly identified that seasonal forecasting methods are

far superior for this dataset than other methods and that multiplicative forecasting methods are somewhat superior to additive forecasting methods in working with this dataset.

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