Computers & Industrial Engineering 74 (2014) 111–119

Contents lists available at ScienceDirect

Computers & Industrial Engineering

journal homepage: www.elsevier.com/locate/caie

Forecasting models for Taiwanese tourism demand after allowance for Mainland China tourists visiting Taiwan

Yi-Hui Liang *

Department of Information Management, I-SHOU University, Taiwan, ROC

ARTICLE INFO

Article history:
Received 21 July 2013
Received in revised form 14 February 2014
Accepted 15 April 2014
Available online 30 April 2014

Keywords:
Tourism demand
Forecasting
SARIMA
GARCH

ABSTRACT

The tourism industry is an increasingly important national industry for Taiwan. Government policymakers and business managers pay close attention to the development of the tourism industry. In a rapidly changing environment that is influenced by numerous socioeconomic factors, the tourism industry must have an accurate method to forecast future tourism demand such that decision makers will be able to meet future challenges more effectively. Based on these concerns, this study proposes the SARIMA–GARCH model to analyze and forecast the tourism demand in Taiwan and compare the predictive power of this model and other forecasting models. The results provide a valuable reference for decision-makers in the tourism industry of Taiwan.

1. Introduction

The tourism industry is an increasingly important national industry for Taiwan. Government policymakers and business managers pay close attention to the development of the tourism industry.

The World Tourism Organisation (WTO), predicted that the number of international tourists worldwide would decrease by 4–6% in 2009 because of the global financial crisis. On the contrary, the number of tourist arrivals in Taiwan in 2009 actually increased. Visitor arrival statistics provided by the Taiwan Ministry of Transportation and Communication (MOTC) Tourism Bureau show that a total of 4,394,967 visitors arrived in Taiwan in 2009, including visitors who came for pleasure, for business, to visit relatives, to attend conferences, to study, or for other purposes. This number of visitors exceeded the 4.1 million visitors originally forecasted by the Taiwan MOTC Tourism Bureau. In 2013, 8,016,270 visitors arrived in Taiwan.

Accurate forecasts of demand for international tourism are important to effectively promote tourism and to allocate sufficient resources for operations, marketing, investment, and financial planning for the Taiwanese tourism industry. Although forecasting demand is vital to all industrial planning, forecasting is particularly crucial in the tourism industry because tourism products and services are inherently perishable (Goh & Law, 2002). In a rapidly changing environment that is influenced by numerous socioeconomic factors, the tourism industry must have an accurate method for forecasting future tourism demand such that decision makers will be able to meet future challenges more effectively. Due to the highly dynamic nature of tourism demand and uncertainty in the business environment, enterprises will have to take significant risks and will face large potential losses if managers in the tourism industry provide poor forecasts.

The dynamics of tourism demand can be understood by scrutinizing numerous sets of time series data that typically cover a broad time span (ranging from days to decades). These time series data sets reflect several features, such as trends and seasonality, which make predictions difficult (Azoff, 1994). Seasonality, in particular, usually has a significant influence on tourism demand (Gil-Alana, Cunado, & Gracia, 2010; Goh & Law, 2002; Lim, 1997).

Quantitative methods for forecasting tourism demand can be divided into three categories: econometric models, time series approaches and artificial intelligence techniques.

Time series approaches can be used to identify recurring patterns and nonlinear relationships (Azoff, 1994). Examples of traditional time series methods are the exponential smoothing method, the moving average (MA) method, the time series decomposition method, and the autoregressive integrated-moving average (ARIMA) and the seasonal ARIMA (SARIMA) models (Box & Jenkins, 1976). The advantage of the SARIMA model compared to the ARIMA model is that the SARIMA model can also consider account data involving trends and seasonality. The ARIMA and SARIMA methods are widely used in forecasting.

The Generalized Autoregressive Conditional Heteroskedastic (GARCH) model (Bollerslev, 1986; Engle, Lilien, & Robins, 1987) is

* Tel.: +886 76577711.
E-mail address: german@isu.edu.tw

http://dx.doi.org/10.1016/j.cie.2014.04.005
0360-8352/

widely used for analyzing and forecasting time series data (e.g., Garcia, Contreras, van Akkeren, and Garcia (2005)). For example, Adrangi, Chatrath, and Raffiee (2001) successfully applied the GARCH model to analyze and explain the behavior of service demand time series data from the United States (US) airline industry. Zhang (2007) used the GARCH model to characterize changes in variance of demand time series data. Datta et al. (2008) explored the possibility of applying the GARCH model to supply chains. Datta et al. (2008) used the GARCH model to analyze the effects of demand amplification and to predict oscillating demand.

GARCH is an acronym for generalized autoregressive conditional heteroskedastic. The order of a GARCH model is represented by $GARCH(p, q)$, where p is the order of the ARCH effect and q is the order of the GARCH effect.

The process assumption in conventional forecasting models suggests that the variance of a time series is homogeneous and constant over time. However, the GARCH model assumes that the variance exhibits temporal heteroskedasticity. A volatile time series with heterogeneous variance is assumed to follow a GARCH process. The GARCH model can be applied to examine variance in tourism demand data to identify dynamic changes over time. Dynamic changes in the variance of tourism demand increase factors such as the out of stock and room risks, excess inventory, and operating costs.

Previously, Bowden and Payne (2008) used three time series models (ARIMA, ARIMA-exponential GARCH (ARIMA–EGARCH), and ARIMA-exponential GARCH-in-mean (ARIMA–EGARCH-M)) for forecasting short-term electricity prices and examining the forecasting performance. Liu and Shi (2013) applied the autoregressive moving average (ARMA) models with GARCH processes, namely ARMA–GARCH models, to model and to forecast hourly electricity prices in advance. The results show that the ARMA–GARCH model is an effective tool for modeling and forecasting the mean and volatility of electricity prices.

Based above, this study aims to apply the time series model (namely the SARIMA–GARCH model) to effectively analyze and forecast the demand for tourism in Taiwan. The proposed method is illustrated by an evaluation of tourism demand in Taiwan. The results of this study provide a valuable reference for decision makers in the tourism industry.

2. Literature overview

Methods for modeling and forecasting tourism demand can be divided into two categories: qualitative and quantitative approaches. The quantitative methods produce more accurate forecasts than forecasts based on qualitative judgments (Makriakis & Hibon, 1979). Song and Turner (2006) concluded that quantitative methods were used in the majority of published studies forecasting tourism demand. The quantitative methods can be further divided into three sub-categories: causal econometric models, time series approaches and artificial intelligence techniques. The difference between the causal econometric methods and the other two methods is that the causal econometric methods must identify causal relationships between tourism demand and the variables that influence this demand. This study mainly discusses time series models and artificial intelligence techniques for forecasting tourism demand.

2.1. Time series models

Time series models use data concerning past values that may influence future values in accordance with underlying deterministic forces. The forces that may be considered in the evaluation of time series data can be characterized as trends, seasonality, cycles and nonstationarity. Naïve I(no change), Naïve II (constant growth rate), moving average, exponential smoothing and census II time series decomposition methods are traditional univariate time series techniques that are commonly used.

The ARIMA and SARIMA (Box & Jenkins, 1976) models also offer effective univariate time series approaches for predicting outcomes based on time series data. The ARIMA models have three advantages over many other traditional single-series approaches: the concepts are derived from a rigorous application of mathematical statistics and classical probability theory, the ARIMA models are a family of models, and research has demonstrated that the proper ARIMA model can obtain optimal forecasts (Chu, 1998).

In one notable study published after 2000, Cho (2001) applied an exponential smoothing method, ARIMA, and an adjusted ARIMA model to predict tourism demand in Hong Kong from different countries. Among the three methods, Cho (2001) suggested that the ARIMA model and the adjusted ARIMA model were both more suitable for forecasting visitor arrivals than the exponential smoothing method.

The tourism sectors reveal significant seasonal patterns, due to the dependence of this industry on many factors, such as the weather (Chu, 1998; Goh & Law, 2002; Lim, 1997). Lim and McAleer (2001) used various exponential smoothing models to forecast tourist arrivals in Australia from Hong Kong, Malaysia and Singapore. Lim and McAleer (2001) suggested that the Holt-winters seasonal exponential smoothing models outperform the single, the double, and the Holt-winters nonseasonal exponential smoothing models. Using ten arrival series data sets for Hong Kong, Goh and Law (2002) found that the SARIMA models outperformed eight other models in forecasting tourism demand including Naïve I, Naïve II, 3-month moving average, 12-month moving average, simple exponential smoothing, Holt exponential smoothing, Winter exponential smoothing and ARIMA models. All the ten major arrival time series were seasonal nonstationary with seasonal unit root. However, Smeral and Wüger (2005) concluded that neither the ARIMA nor the SARIMA model outperformed the Naïve I model in forecasting Australian tourism demand.

In another study, Chu (2008) incorporated univariate fractionally integrated $ARMA(p, d, q)$ (ARFIMA) to forecast the demand for tourism in Singapore. Chu (2009) applied three univariate ARMA-based models, including the ARFIMA, ARAR and SARIMA models, to forecast tourism demand in nine Asian-Pacific countries and found that the ARFIMA model is superior to the ARAR and SARIMA models.

Another forecasting approach is the TVP techniques for forecasting tourism demand. Li, Wong, Song, and Witt (2006) introduced the time varying parameter (TVP) forecasting technique and applied this technique to tourism demand analysis.

Naïve I, Naïve II, moving average, exponential smoothing and census II time series decomposition methods have also frequently been used in studies published after 2000, but these methods are commonly taken as benchmarks for evaluating forecast accuracy (Song & Li, 2008).

2.2. Artificial intelligence techniques

This new wave of neural network activity was restarted by the research of Rumelhart, Hinton, and Williams (1986), who examined multilayer perceptron neural network architecture with a back-propagation algorithm. The back-propagation neural network model with gradient descent algorithm is the most frequently employed model among neural network techniques. A typical back-propagation neural network model with gradient descent algorithm comprises three or more layers, including the input layer, one or more hidden layers, and the output layer. Backpropagation is the process of back-propagating errors through the