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Using a logistic growth regression model to forecast the demand for tourism in Las Vegas

Fong-Lin Chu *

Graduate Institute of National Development, College of Social Science, National Taiwan University, No. 1, Roosevelt Road, Sec. 4, Taipei, Taiwan

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ABSTRACT

For many years significant attention has been devoted to the application of forecasting models, both causal and time series, to the demand for tourism. However, most studies use national data and only a few are destination specific. The present paper applies a logistic growth forecasting model to tourist demand for Las Vegas and the empirical results indicate a superiority of logistic growth model when compared to the benchmark seasonal autoregressive integrated moving average (SARIMA) and Naïve 1 models. Based on the accuracy criteria of mean absolute percentage error and root mean square percentage error, the present study demonstrates that forecasts of tourism demand obtained by logistic growth forecasting model are more accurate (and hence more useful to tourism managers and planners) than forecasts obtained through any of the two benchmark models.

1. Introduction

For years, in many parts of the world the tourism industry has been the driving force for enhancing economic growth through increasing per capita income, employment, and foreign exchange earnings (World Tourism Organization, 2005). Achievement of such objectives, however, necessitates the appropriate investments made in both the public and private sectors. Decisions related to infrastructure, accommodations, transportation, attractions, promotion, and other services depend upon reasonably accurate forecasts of how many tourists will be served, their seasonality, and their service needs (Uysal & Crompton, 1985). Las Vegas tourism industry is no exception and reliable forecasts of tourist arrivals can provide valuable information for pricing, facility monitoring, seasonal employment, and short-term budgeting. With respect to developing long-run plans, forecasts can determine future infrastructure needs, new facilities and utilities, and future staffing.

The present study proposes an S-shape curve model that enables forecast professionals to achieve accurate forecasts of tourist flows to Las Vegas. A logistic growth regression model that accounts for demand saturation patterns is suggested to model and forecast Las Vegas tourism. Such model is prominent among the many growth models and has been widely used to describe the growth of a phenomenon in many areas of both the social as well as the physical science (Larson & Marx, 1986). In economics, it might be the rise of a financial institution; in marketing, the sales of new products over time; in political science, the gradual acceptance of a government policy; in journalism, the spread of information within societies; and in biology, the doubling time of Drosophila population. Given the fundamental pattern contained in the data series of demand for Las Vegas tourism, the logistic growth regression model provides a simple, inexpensive and still quite acceptable means of forecasting.

The following outlines the plan of the paper. Section 2 gives brief remarks to Las Vegas tourism and reviews previous efforts to forecast demand for tourism. In Section 3 the logistic growth regression model is introduced and the estimation procedure is discussed. The section that follows presents the empirical results and compares them with those of two benchmark models, whilst the final section concludes.

2. Las Vegas profile and literature review

Established in 1905, Las Vegas officially became a city in 1911. With the growth that followed, at the close of the century Las Vegas was the most populous American city founded in the 20th century. The primary drivers of the Las Vegas economy have been the confluence of tourism, gaming and convention which in turn feed the retail and dining industries. According to statistics from tourism officials, 38.93 million tourists had visited Las Vegas in 2011 (Las Vegas Convention and Visitors Authority, 2012). This is the second highest level of tourists that had visited Las Vegas. In 2007 Las Vegas hosted a record-breaking 39.2 million visitors (see Fig. 1).

Over the years, many efforts have been made to the forecasting of demand for tourism (see Van Doorn (1984), Uysal and Crompton (1985), Witt and Witt (1995) and Song and Li (2008) for a survey). However, most researches are for the international destinations, with only a few for a region within a country. Geurts and Ibrahim (1975) and Geurts, Buchman, and Ibrahim (1976) use the Box–Jenkins

* Tel.: +886 2 33663326; fax: +886 2 23676176.
E-mail address: flchu@ntu.edu.tw.

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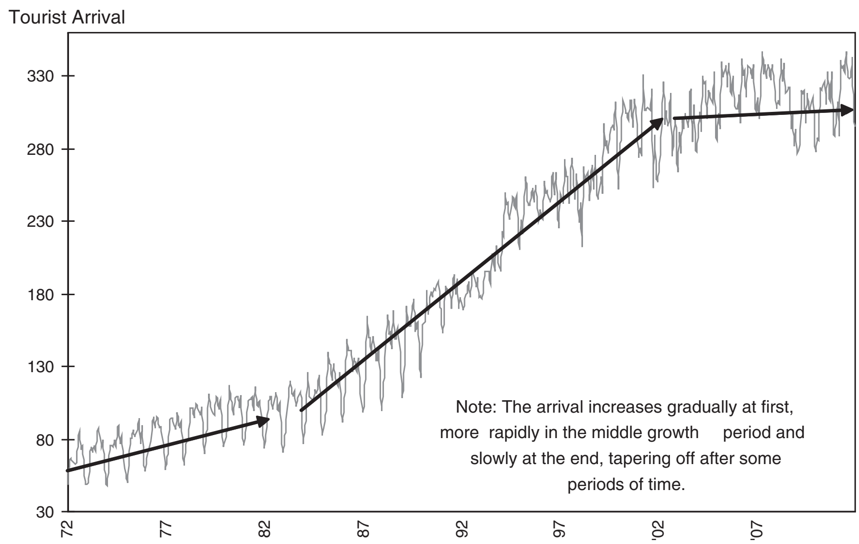

Fig. 1. Monthly tourist arrivals in Las Vegas time bounds: January 1972–December 2011.

autoregressive integrated moving average (ARIMA) models to forecast Hawaii tourism and compare the results to an exponential smoothing model. Bunn (1979) has also examined the number of tourists visiting Hawaii series and suggested a synthesized method to increase its accuracy in a forecasting effort. Geurts (1982) reexamines the Hawaii data (from Geurts & Ibrahim, 1975) and compares both ARIMA and exponential smoothing to "data modified exponential double smoothing" and found the latter to be a superior forecasting method. Fuji and Mak (1981) use 1961–1973 annual data to estimate U.S. visitor demand for travel to Hawaii and generate forecasts for 1974–1978. They demonstrate that the employment of extended Box-Cox autoregressive tests for functional form and ridge regression to control for the effects of substantial and changing patterns of collinearity among the explanatory variables substantially increases forecast precision relative to ordinary least squares and generalized least squares forecasts. Liu (1988) collects the opinions of local experts and travel agents about the future developments of visits to Hawaii up to 2000; the study finds that human predictions are generally consistent with quantitative estimates and concludes that the combination of qualitative and quantitative methods is appropriate for long-term forecasting. Calantone, di Benedetto, and Bojanic (1988) use several combined forecasts of tourist arrivals in Florida obtained to compare to single-method forecasts gained through econometric or time-series methods. Fritz, Brandon, and Xander (1984) combine the Box–Jenkins stochastic time-series method with a traditional econometric technique to forecast airline visitors to the State of Florida. Silberman and Klock (1986) develop cross-sectional regression models to explain variation in visitor flows to Virginia Beach. Perdue (1996) adopts cross-sectional regression models to examine demand for Colorado skiing. Song and Witt (2006) use vector autoregressive modeling technique to forecast tourist flows to Macau from eight major countries/regions. Chu (2011) constructs and uses a piecewise linear method to model and forecast the demand for Macau tourism. Law (2000), Law and Au (1999) and Cho (2003) directed their studies toward the forecast of demand for tourism in Hong Kong using various forecasting models. Tsui, Balli, Gilbey, and Gow (2014) employ the SARIMA model and the ARIMAX model to forecast airport passenger traffic for Hong Kong, and project its future growth trend to 2015. Malamud (1973) explains tourist travel to Las Vegas by developing a gravity model without forecasts. Reese (2001) measures the impacts of demographic, life-style, and distance variables on travel to Las Vegas and to Atlantic City using data at two levels of aggregation and at the individual household level. Witt, Newbould, and Watkins (1992) use data on Las Vegas to generate monthly forecasts and demonstrate that the exponential smoothing and Naïve 2 (the forecast for period $t+1$ is equal to the actual number of arrivals in period t multiplied by the growth rate over the corresponding previous period) beat Naïve 1 forecasts. Despite the fact that it is an internationally renowned major resort city and hosted approximately 39.2 million visitors in 2011, Las Vegas has received only scant attention in the literature on the issue of tourism demand forecasting. The aim of this paper is to fill this scholarly gap with a logistic growth forecasting model. SARIMA and Naïve 1 models are then used as benchmark to test the accuracy of the proposed model.

3. A logistic growth forecasting model

A logistic growth curve is given by

$$y_t = \frac{\phi_1}{1+\beta\gamma^t} \quad \gamma>0 \tag{1}$$

where t is the time and y_t is the demand for tourism at time t. Eq. (1) represents an S-shaped curve which might be used to represent the demand for tourism that will someday saturate the market so that the total number of visitors will approach some plateau, or equivalently, additional visitors will approach zero. This is exactly a feature seen in Fig. 1 where the numbers of tourist arrivals in Las Vegas are plotted. The arrival increases gradually at first as a result of small tourist size, from 1984 onward more rapidly in the middle growth period, and slowly at the end, leveling off at a maximum value of 37–38 million after some period of time. Eq. (1) is nonlinear in the parameters ϕ_1, β and γ, and in general, is estimated using nonlinear estimation procedure. However the following approximation to the logistic growth curve can be estimated using linear ordinary least squares method: $\frac{\nabla y_t}{y_{t-1}} = \phi_1 + \phi_2 y_{t-1}$ in which ∇ denotes the differencing operator defined such that $\nabla y_t = y_t - y_{t-1}$. This equation is a discrete-time approximation to the differential equation $\frac{dy}{dt} = \phi_2 y(\phi_1 - y) = \phi_2 y\left(1-\frac{y}{\phi_1}\right)$, and the solution to this differential equation has the form of Eq. (1) (Pindyck & Rubinfeld, 1991). The solution to differential equation $\frac{dy}{dt} = \phi_2 y(\phi_1 - y) = \phi_2 y\left(1-\frac{y}{\phi_1}\right)$, after integrating both sides of the equation, is $y_t = \frac{\phi_1}{1+\left(\frac{\phi_1-y_0}{y_0}\right)e^{-\phi_2 t}} = \frac{\phi_1}{1+\beta\gamma^t}$, where ϕ_1 is the limit to the growth, $\beta = \frac{\phi_1-y_0}{y_0}$ is the number of times y (the number of tourist) should grow from initial value y_0 to reach ϕ_1, y_0 is the initial tourist arrivals, $\gamma = e^{-\phi_2 t}$, e is the base of natural logarithms