Tourism Management 33 (2012) 1122–1127

Contents lists available at SciVerse ScienceDirect

Tourism Management

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

Benchmarking the Asia Pacific tourism industry: A Bayesian combination of DEA and stochastic frontier

A. George Assaf*

Isenberg School of Management, University of Massachusetts-Amherst, 90 Campus Center Way, 209A Flint Lab, Amherst, MA 01003, United States

ARTICLE INFO

Article history:
Received 3 April 2011
Accepted 25 November 2011

Keywords:
Efficiency
Tourism
Asia Pacific
Tour operators
Hotels
Empirical Bayes

ABSTRACT

This study measures and compares the efficiency of leading tour operator and hotel companies across several Asia Pacific countries. We use an innovative methodology that is based on combining the stochastic frontier and data envelopment analysis in a Bayes framework. We show from the results that Australia, Singapore and South Korea are the most efficient in both their tour operator and hotel industries. We further show that international hotels in the region have a slightly higher efficiency than local hotels. We provide a listing of the most efficient tour operators and hotels in each country and discuss the implications of our findings.

1. Introduction

This paper aims to offer more accurate and fresh insights into the level of performance of major tourism operations in the Asia Pacific region. It is well established that tourism is an important economic driver and major source of foreign exchange earnings for many Asia Pacific countries. It also contributes significantly to the employment in these countries, helps in the creation of new businesses, and plays an important role in the revival of regional centers and in achieving environmental sustainability (Wang, 2010). In Australia, for example, tourism contributed $38.9 billion to Australia's Gross Domestic Product (GDP) in 2006–07, representing around 3.7 per cent of the Australian economy in the last ten years. The industry holds a high share in terms of Australian employment (4.7 per cent, or 482,800 jobs) and Australian exports (10.5 per cent, or $22.4 billion). The industry has also important impact in New Zealand; it contributes $18.6 billion to the economy each year—9% of New Zealand's gross domestic product. It also makes a large contribution in Thailand, Japan and South Korea and ranks among the three most important industries in Hong Kong, Malaysia, the Philippines, Singapore and Indonesia (IBISWorld, 2009).

The tourism industry in most of these countries was generally growing rapidly over the last ten years, until recent negative trends affected its growth. For example, the safety fears changed the environment for travel and tourism and threatened the predicted growth of tourism both globally and locally (Travel and Tourism-Australia, 2009). The recent economic crisis also affected business and travel activities, and resulted in less tourism spending (Global Travel and Tourism, 2009). Some measures that are currently being taken by Asian Pacific governments to assist tourism operations include the improvement of tourism competitiveness, facilitation of travel and investment activities, diversification of the economy, and the promotion of innovative launching initiatives (IBISWorld, 2009).

We focus here on the efficiency analysis of tourism operations from both the tour operator and hotel industries. Both these industries play an essential role in the tourism industry of the Asia Pacific region. They also present an excellent context for efficiency analysis as they operate in a high competitive environment. The hotel and tour operator industries have both recently experienced a sharp decline in revenues as a result of the economic crisis and drop in international travel. Hotel occupancy rates, particularly in higher-end hotels declined significantly in the second half of 2008. The competition in the tour operator industry also continues to increase with the fluctuation in flight prices, and the political instabilities in some counties like Thailand and India (Global Travel and Tourism, 2009).

The present study introduces a sample that allows for a cross-country comparison. The existing literature is replete with studies that are mostly limited to one single country (e.g. Barros, Botti, & Peypoch, 2010; Barros, Botti, Peypoch, & Solonandrasana, 2009; Chiang, Tsai, & Wang, 2004; Hwang & Chang, 2003; Köksal & Aksu, 2007). All these studies have important merits, but the focus on

* Tel.: +1 4135451492.
E-mail address: assaf@ht.umass.edu.

0261-5177/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tourman.2011.11.021

a single country limits the benchmarking comparison (Assaf & Dwyer, in press). It is more important for governments and tourism operators to evaluate how their hotel industry is performing at the regional level, or at least against their major competitors (Blanke & Chiesa, 2009). The methodology used in the study is also unique and innovates on related studies in the area. For the first time we combine the strength of both the data envelopment analysis (DEA) and stochastic frontier (SF) models in one methodology. Specifically, we use the DEA efficiency measures as priors of efficiency in the stochastic frontier model. These priors are then used to obtain posterior estimates of efficiency using the Bayes' theorem. We provide below more details about the methodology.

The paper proceeds as follows: Section 2 presents the literature review; Section 3 discusses the methodology; Section 4 describes the data; Section 5 presents the results and Section 6 presents the discussions and concluding remarks.

2. Literature review

The performance literature related to the tourism industry has developed rapidly over the last few years, driven mainly by the growing competition between tourism destinations which left the industry under as much pressure, if not more, than other industries to improve productivity. The link between performance measurement and strategy formulation is clear in the literature (Majumdar, 1998; Majumdar & Venkatraman, 1998). Performance measurement enables an organization to monitor its effectiveness in achieving goals and objectives, managing products and services, and obtaining product/service results (customer satisfaction). It is closely linked to efforts to make strategic plans, clarify organizational goals and objectives, and characterize decision-making needs (Delmas, Russo, & Montes-Sancho, 2007; Durand & Vargas, 2003; Schefczyk, 1993).

There are several studies in the literature that provided recent and updated reviews on the performance studies in the tourism industry (Assaf, Barros, & Josiassen, 2010; Barros & Dieke, 2008; Fuentes, 2011; Perez-Rodríguez & Acosta-González, 2007). Generally, there is a clear trend in shifting away from simple performance methods (such as those based on ratio analysis), relying instead on more sophisticated methodologies such as the data envelopment analysis (DEA) and stochastic frontier (SF) methods. Both these methods are based on the concept of frontier estimation, where a technology of best practices is first estimated, and then the efficiency of a particular firm is measured by assessing its distance from that technology (i.e. a frontier that represents fully efficient firms). The literature on the DEA method is significantly larger (Assaf et al., 2010; Assaf & Knežević, 2010; Barros, 2005; Barros & Alves, 2004; Barros et al., 2011; Barros & Dieke, 2008; Bell & Morey, 1995; Hwang & Chang, 2003; Köksal & Aksu, 2007; Morey & Dittman, 1995; Reynolds, 2003; Reynolds & Thomson, 2007; Sigala, Airey, Jones, & Lockwood, 2004; Wang, Jui-Kou, & Wei-Ting, 2006; Yu & Lee, 2009). There are fewer papers that used the SF method; some leading studies include Anderson, Mary, Yi, and Michello (1999) and Anderson, Randy, and Fok (1999), and Chen (2007).

Two important gaps can be noticed from the current literature. First, most existing studies tend to focus on one single country or geographical area, and second; they are mainly limited to the hotel industry. We aim in this study to extend the present literature both in terms of scope and method. Instead of focusing on one particular country, the focus here is on comparing several countries, thus allowing for a more comprehensive benchmarking. The study also provides a methodological contribution to the current literature. We estimate the SF method in a Bayesian framework, while using the DEA efficiency scores as priors. Therefore, our approach combines the strength of both methodologies. The relative merits of the Bayesian and sampling theory approaches to inference have also been well established in the literature (Geweke, 1986; Poirier, 1995). We explain in more detail in the following section the advantages of the methodology used in this study.

3. A Bayesian combination of DEA and stochastic frontier

As illustrated from the above literature, the DEA and SF methods have been used in many related studies. The two methods have their own advantages and disadvantages. DEA is more flexible in the case of multiple inputs and outputs but cannot deal effectively with measurement error in the data, whereas SF is more effective in the presence of noise (Charnes, Cooper, & Rhodes, 1978; Greene, 1993; Koop, Steel, & Osiewalski, 1995; Lovell, 1993; Tsionas, 2003).

In this paper we combine the strengths of the two approaches using the Bayes approach. The purpose is to use DEA in order to improve the accuracy of the SF efficiency estimates. Consider the following stochastic frontier model[1]:

$$y_i = \mathbf{x}_i'\boldsymbol{\beta} + v_i - u_i, \quad i = 1, \ldots, N \tag{1}$$

where y_i is the dependent variable representing the output of the i-th firm, $\mathbf{x_i}$ is a $k \times 1$ vector of explanatory variables, $\boldsymbol{\beta}$ is a $k \times 1$ vector of parameters, v_i is a symmetric random error that accounts for statistical noise, and u_i is a non-negative random variable that follows a truncated distribution $u_i \sim IN(\mu_i, \omega^2)$ and represents inefficiency. It is assumed that v_i and u_i are mutually independent as well as independent of $\mathbf{x_i}$.

Thus, the stochastic frontier model contains a composed error term: $\varepsilon_i = v_i - u_i$. Several authors discussed that this is sometimes troublesome as in the case where the noise is high, ε_i would appear approximately symmetric in which case the identification of the efficiency component (u_i) becomes problematic (e.g. Kumbhakar & Lovell, 2000; Tsionas, 2003). As stated above, u_i follows a truncated distribution $u_i \sim IN(\mu_i, \omega^2)$. The mean of this distribution is: $E(u_i|\mu_i, \omega) = \mu_i + \omega \Lambda(\mu_i, \omega)$, where $\Lambda(\mu_i, \omega) \equiv \phi(\mu_i, \omega)/\Phi(\mu_i, \omega)$, ϕ denotes the standard normal probability density function, $\phi(z) = (2\pi)^{-1/2} \exp(-z^2/2)$, and Φ denotes the standard distribution function.

It is common in the stochastic frontier model that when deriving the efficiency measures to assume $\mu_i = \mu$ for all $i = 1, \ldots, n$, and treat μ as a parameter. This can be problematic as the likelihood of the model can turn out to be flat in the direction of μ unless a very large data set is used. As stated above, it becomes difficult in this situation to discriminate between noise and efficiency. What we do here is we take μ_i directly from the DEA efficiency scores, avoiding this way the need to specify a parametric model of μ_i. In other words, we use the DEA efficiency scores,[2] as priors in the Bayes estimation of the stochastic frontier model. These priors are then used to form posterior estimates from the stochastic frontier model.

The Bayes theorem requires information about the prior of the parameters plus the likelihood:

$$p(\theta|\mathbf{y}, \mathbf{X}) \propto L(\theta; \mathbf{y}, \mathbf{X}) p(\theta) \tag{2}$$

where $p(\theta|\mathbf{y}, \mathbf{X})$ is the posterior distribution, $L(\theta; \mathbf{y}, \mathbf{X})$ is the likelihood, and $p(\theta)$ is the prior. The likelihood of the stochastic frontier model is well established in the literature and can be expressed as:

$$L(\boldsymbol{\beta}, \sigma, \omega, \mathbf{u}; \mathbf{y}, \mathbf{X}) \propto \sigma^{-N} \omega^{-N} \exp\left[-\frac{(\mathbf{y} + \mathbf{u} - \mathbf{X}\boldsymbol{\beta})'(\mathbf{y} + \mathbf{u} - \mathbf{X}\boldsymbol{\beta})}{2\sigma^2} \right] \times \exp\left[-\frac{(\mathbf{u} - \boldsymbol{\mu})'(\mathbf{u} - \boldsymbol{\mu})}{2\omega^2} \right] \prod_{i=1}^{N} \Phi(\mu_i/\omega)^{-1} \tag{3}$$

[1] The equations used in this section are largely dependent on Tsionas (2003).

[2] We use here an output oriented DEA model.