International Journal of Hospitality Management 29 (2010) 468–475

Contents lists available at ScienceDirect

International Journal of Hospitality Management

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

Hotel efficiency: A bootstrapped metafrontier approach

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ARTICLE INFO

Keywords:
Efficiency
Data envelopment analysis
Metafrontier
Taiwanese hotels

ABSTRACT

This paper introduces the metafrontier concept to account for the environmental and technological differences between various hotels groups. The interesting feature of the model is that it ensures that heterogeneous hotels are compared based on one homogenous technology. We test the model using a panel data sample of 78 Taiwanese hotels. The results clearly indicate that the size, ownership, and classification of a particular hotel have a significant impact on its efficiency. More implications of the results are provided.

1. Introduction

The importance of efficiency in the daily operations of the hotel industry is well supported and evidenced in the literature. Currently, efficiency studies cover several international hospitality industries such as Portugal (Barros and Santos, 2006; Barros, 2005a,b; Barros and Mascarenhas, 2004), Taiwan (Hwang and Chang, 2003), the US (Anderson et al., 1999a,b; Anderson et al., 2000; Reynolds, 2003; Brown, 2002); and the UK (Johns et al., 1997). An important characteristic of the modern efficiency literature on hotels relates to the extensive use of advanced efficiency methods such as DEA (data envelopment analysis) and SFA (stochastic frontier analysis) which are relatively flexible methods and can simply account for the multiple inputs/outputs setting of the industry (Barros and Dieke, 2008).

A review of the current literature indicates however that most existing studies tend however to suffer from one common limitation in terms of accounting for the impact of environmental variables on efficiency. For example, environmental factors such as size, location, and type of ownership are all uncontrollable variables that can interfere with the efficiency results and thus should be carefully addressed. A review of the literature clearly indicates that most of the current studies tend to combine hotels belonging to different environmental groups (e.g. small and large hotels) in one data sample prior to the estimation of efficiency. The impact of environmental variables is then determined by using either a second stage regression (Barros and Dieke, 2008) or analysis of variance (ANOVA) (Chen, 2007). While it is true that these approaches might provide some inferences on the impact of environmental variables on efficiency, the idea of combining heterogeneous hotels in one sample may in the first place distort the efficiency results and subsequently the results of the second stage regression or the ANOVA model.

Such issue was recently raised by O'Donnell et al. (2007) who argued that the SFA or DEA methods might sometimes lead to inaccurate results if the sample under consideration includes firms which belong to different environmental characteristics. This is because the efficiency frontiers for these firms might not be identical to provide an unbiased comparison. For example, large and small hotels have different characteristics in terms of economies of scale, market share, and access to advanced technologies and thus should not be treated as one homogenous group. To account for this heterogeneity problem, O'Donnell et al. (2007) have recently provided a methodological solution by introducing the concept of metafrontier which can ensure that all heterogeneous firms or groups are assessed based on their distance from a common and identical frontier. In a simple definition the metafrontier function can be considered as an envelop of all possible frontiers that might arise from the heterogeneity between firms (Rao et al., 2003). In other words it aims to provide a homogenous boundary for all heterogeneous firms. The impact of environmental variables can then be measured more accurately by assessing the distance of a firm belonging to a certain environmental group from the metafrontier.

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doi:10.1016/j.ijhm.2009.10.020

In this paper we aim to extend the application of the metafrontier to provide further evidence on the impact of environmental variables on hotel efficiency. We divide the hotels into three heterogeneous groups according to three environmental characteristics: size, classification, and type of ownership. These variables are the most popular in several efficiency studies, and were found in most cases to be strong determinants of hotel efficiency. In testing the model we use a sample of Taiwanese hotels ranging from years 2004 to 2008. In this way the study also contribute the analysis of efficiency in this country as none of the previous studies has applied the metafrontier concept. The estimation of the metafrontier is further enhanced with the use of the bootstrap approach which can be used to examine the statistical properties of efficiency scores generated through the metafrontier.

The paper unfolds as follows: Section 2 provides the literature review, followed by a discussion of the metafrontier model and the DEA bootstrap in Section 3. A description of the data and variables used is provided in Section 4. Section 5 presents the results and Section 6 presents discussions and summary of the main findings.

2. Literature survey

The efficiency and productivity literature in tourism is old and well established. Table 1 presents a survey of the published literature, as well as the methodologies and data used.

It is clear that none of the previous studies have followed the metafrontier approach. Other advanced models such as the Bayesian stochastic frontier, random frontier, and latent frontier models are also yet to reach the hospitality and tourism literature (Lewis and Anderson, 1999; Greene, 2005; Orea and Kumbhakar, 2004). With regards to the policy implications of the studies reviewed, they vary, but in general, they propose policies to overcome the identified inefficiency.

3. Technical details of the metafrontier model

To introduce the metafrontier model, let y and x, respectively, denote non-negative output and input vectors of dimensions $(N \times 1)$ and $(M \times 1)$ respectively. We consider the case where there are $K(>1)$ groups and each group operates under a specific technology, $T^k (k = 1, 2, \ldots, K)$. Battese et al. (2004) argued that since technology is a state of knowledge related to the transformation of N input into M outputs, it is possible to conceptualize the existence of an over-arching technology or metatechnology, which they represent by T^*.

The technology of a given group, called technology set, is defined as the set of all feasible input–output vectors.

$$T = \{(x, y) \in R_+^{p+q} | x \text{ can produce } y\} \quad (1)$$

which describes the amount of some p inputs x that can produce q outputs y. We can define the input and output sets associated with the production technology set T, which provides an equivalent representation of production technology. The input set defined for a specific output vector y is the set of all input vectors x which can produce y.

$$X(y) = \{x : (x, y) \in T\} \quad (2)$$

The boundaries for the input sets determine the 'isoquants'. The output set is defined for a specific vector of input x as the set of all output vectors y which can be produced using x :

$$P(x) = \{y : (x, y) \in T\} \quad (3)$$

The boundary of the output set is the production possibility frontier and represents technically efficient production. The

Table 1
Literature survey of frontier models on tourism.

Study	Method	Units	Inputs	Outputs	Prices	Contribution
Data envelopment analysis papers						
Chen (2009)	DEA with slacks	Data from a questionnaire	(1) Number of employees (2) Surfaced area, (3) guest rooms (4) Operating expenses (5) Depreciation expenses	(1) Occupancy rate (2) Rate of guest satisfaction (3) Number of guests (4) Room revenue (5) Other revenue		Role of slacks on efficiency
Reynolds and Biel (2007)	DEA	Data on 32 surveys undertaken in a 36 same-brand restaurants	(1) Costs of goods sold (2) Labor costs (3) Employee satisfaction (4) Rent (5) Taxes and insurances (6) Square footage (7) Number of seats	(1) Revenue (2) Profit (3) Guest satisfaction (4) Average purchase frequency		Role of satisfaction on efficiency
Reynolds and Thompson (2007)	DEA	60 brand restaurants from a chain	(1) Server wage (2) Seats (3) Square footage (4) Units in the same State (5) Several other contextual variables	(1) Sales (2) Tips (3) Turnover		Focus on restaurant chain efficiency