Original Article

Cornell Hospitality Quarterly
1–12

DOI: 10.1177/1938965518762841
journals.sagepub.com/home/cqx
SAGE

Estimation of Profit Efficiency in the Hotel Industry Using a Bayesian Stochastic Frontier Model

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Abstract

The present study measured profit efficiency and its determinants in the hotel sector in Spain from 2010 to 2014, using a Bayesian stochastic frontier approach. This model provides estimates of efficiency and more accurate confidence intervals than the traditional frequentist approach. The results revealed that the hotels are operating with significant profit inefficiencies. These inefficiencies are significantly affected by size, location, occupancy rate by region, customer satisfaction, and whether the hotel is affiliated or independent. Finally, the study points out the strategic implications of these findings, to improve the efficiency of the hotels.

Keywords

profit efficiency, Bayesian stochastic frontier, hotel industry

Introduction

The importance of measuring business performance has been demonstrated in the literature, particularly in the tourism literature. Strategic management focuses its attention on identifying companies with a profit above the average reached in the sector, the sources of their competitive advantages, and how to create them (Barney, 1991; Porter, 1980; Rumelt, 1984). If a company has a profit above average in a continuous manner, it can be confirmed that it has a sustained competitive advantage (Amit & Schoemaker, 1993; Barney, 1991). Performance has thus become a central concept that allows evaluation of the greater or lesser success of business strategies to improve the competitive position of companies in the market.

Traditionally, indicators based on accounting have been used to measure performance in the hotel sector, such as average assets yield, revenue per room, and average rate of occupancy, among others. However, these measurements are very limited owing to the different accounting standards among companies (A. G. Assaf & Josiassen, 2016) and because the measurements only assess the financial dimension of performance and ignore other relevant dimensions. A purely financial measurement does not take into consideration that the efficiency with which a company transforms its resources can be the main source of its competitive advantage (Chen, Delmas, & Lieberman, 2015). In addition, whereas a financial measure can provide information about the profits of a hotel, it does not reveal how much more profit could be obtained if the hotel were fully efficient.

Efficiency, on the contrary, is an economic indicator that reflects the effects that resource management has on profits. Hotels can achieve a better performance by not just managing their inputs more efficiently, but also by improving their ability to set higher prices for their services. The concept of efficiency that best considers these two important economic objectives (i.e., cost minimization and revenue maximization) is profit efficiency. "The profit efficiency concept is superior to the cost efficiency concept for evaluating the overall performance of the firm. Profit efficiency accounts for errors on the output side as well as those on the input side . . ." (Berger & Mester, 1997, p. 900). This concept measures not only a hotel's efficiency but also the maximum potential profit that could be obtained if the hotel were fully efficient. Consequently, profit efficiency provides more useful information about the performance of a hotel, and therefore, management will be interested in knowing its measurement.

Just as important as measuring efficiency is knowing the factors that determine it. This is an aspect that is not addressed in the previous literature despite its relevance for hotel planning and management (Alberca-Oliver, 2014). From management's point of view, identifying these factors is fundamental for the development and implementation of

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different policies and business strategies that allow hotels to improve their results (Lovell, 1993). The literature indicates that the size, accumulation of knowledge, quality of service, type of property, labor productivity, location, level and quality of infrastructure, and economic conditions in the country are the main determinants of hotel efficiency.

Frontier models allow the assessment of efficiency and understanding of the performance of a company beyond the mere comparison with profitability or financial performance (Chen et al., 2015). These models estimate the relative efficiency of a company by comparing it with the best-practice firm of the sample, with efficiency representing a measure of the performance. Their main feature is that they provide an estimate of efficiency, revealing the gap between the current performance of a company and its optimal performance (Coelli, Rao, O'Donnell, & Battese, 2005).

Data envelopment analysis (DEA) and the stochastic frontier approach (SFA) are the frontier models most used in the hotel industry to estimate efficiency. The main difference between these two methods is that the DEA is a nonparametric technique that estimates the optimal frontier using mathematical programming techniques, whereas the SFA is a parametric method that allows the statistical properties of estimates to be obtained. In addition, the SFA allows the existence of a composite error, which includes the effect of variables that are not under the control of the company and the term inefficiency. The DEA does not consider the existence of possible random errors in the data.

Despite the advantages of these methods and the fact that they have been widely used in the literature on hotel efficiency,[1] there are more recent versions that provide more robust efficiency estimates, as in the case of the Bayesian SFA (A. G. Assaf & Magnini, 2012). The Bayesian SFA has the following advantages over the traditional estimation methods (e.g., maximum likelihood): (a) The results are expressed in terms of probability density functions, which allows probability statements to be made about the unknown parameters, hypotheses, and models. (b) It is more flexible, as it incorporates a priori information about the parameters of the model. and (c) It provides individual-specific estimates of the model parameters (A. Assaf, 2009, 2011; A. G. Assaf & Josiassen, 2016; A. G. Assaf, Oh, & Tsionas, 2016; Coelli et al., 2005). Despite the advantages of this method, most studies on hotel efficiency are based on a frequentist approach. There are few investigations that have used Bayesian techniques to estimate hotel efficiency, and all have focused on the analysis of cost efficiency (cost minimization; A. Assaf, 2009, 2012; A. G. Assaf & Barros, 2013; A. G. Assaf & Cvelbar, 2011; A. G. Assaf & Magnini, 2012).

The purpose of this article is to estimate profit efficiency in the hotel industry and its determinants, using a Bayesian stochastic frontier model in a sample of 312 hotels in Spain from 2010 to 2014. This study aims to extend the existing literature on hotel efficiency, making three important contributions: (a) measuring profit efficiency using a novel technique, that is, the Bayesian approach; (b) validate the results of previous studies that used other estimation techniques, such as maximum likelihood; and (c) analyze size, affiliated versus independent, location, client satisfaction, and occupancy rate by region as possible determinant factors of profit efficiency and therefore identify different areas of efficiency improvement for the hotel industry. This analysis is particularly interesting for both management and tourism policy makers to respond to the important economic issues of the sector.

This article is organized as follows: a brief review of the literature is presented in the "Literature Review" section. The subsequent three sections, namely, "Method," "Data and Selection of the Variables," and "Empirical Results," present the method used in the study, the data, and the discussion of the results. The "Conclusions and Implications" section discusses the implications and presents the final conclusions.

Literature Review

The literature on hotel efficiency has developed extensively in the last decade, partly because its importance has gradually increased in the economy of many countries and also as a result of increasing competitiveness in the hotel industry. There has thus been a growing interest from both professionals and researchers in analyzing the performance of hotels and its determinants.

Most studies of hotel efficiency (Anderson, Fish, Xia, & Michello, 1999; Anderson, Fok, & Scott, 2000; A. G. Assaf & Agbola, 2011; A. G. Assaf & Cvelbar, 2011; Arbelo, Pérez-Gómez & Arbelo-Pérez, 2017; Barros, 2004, 2005, 2006; Barros & Dieke, 2008; Barros, Dieke, & Santos, 2010; Barros & Mascarenhas, 2005; Brown & Ragsdale, 2002; Chen, 2007; De Jorge & Suárez, 2014; Hwang & Chang, 2003; Parte-Esteban & Alberca-Oliver, 2015; Pérez-Rodríguez & Acosta-González, 2007) have used traditional frontier models, such as the DEA and SFA, to estimate the efficiency of costs, indicating the level of efficiency of the hotels in the use of inputs for the provision of their services.

However, the literature regarding the determinants of hotel efficiency is less extensive and practically null in the case of profit efficiency. In this sense, Chen (2007) reveals that operation type (i.e., affiliated vs. independent) is a key factor in determining hotel efficiency, although there is no statistical evidence that size and location affect efficiency. However, Barros (2005) indicates that location and economies of scale are determining factors of hotel efficiency. Wang, Hung, and Shang (2006) also conclude location and belonging to a chain have positive and significant effects on efficiency; on the contrary, accumulation of knowledge does not have a significant influence on efficiency. Pérez-Rodríguez and Acosta-González

(2007) find a positive relationship between hotel efficiency and labor productivity. Hu, Chiu, Shieh, and Huang (2010) study the effect of a series of environmental variables on efficiency, revealing that with the exception of hotels located outside metropolitan areas, belonging to a hotel chain, the number of tourist guides and being located near international airports have positive effects on efficiency. A. G. Assaf and Cvelbar (2011) find that hotel efficiency is positively related to the percentage of private ownership of hotels and international attractiveness and negatively related to management tenure. Oliveira, Pedro, and Marques (2013) conclude that the location and existence of golf courses may have some relevance as efficiency determinants; however, the number of stars a hotel has does not. De Jorge and Suárez (2014) reveal that size and efficiency have a U-shaped relationship, whereas market share and the degree of organizational autonomy are positively related to efficiency. Arbelo et al. (2017) find significant and positive relationships between labor productivity, accumulation of knowledge, location, and hotel efficiency.

The Bayesian approach has recently begun to be used in the hotel industry, with the studies conducted by A. G. Assaf and Barros (2011), A. G. Assaf and Cvelbar (2011), A. G. Assaf (2012), A. G. Assaf and Magnini (2012), and A. G. Assaf and Barros (2013). This shows that the Bayesian approach has scarcely been used in studies on hotel efficiency and its determinants, and the few existing studies have focused on measuring cost efficiency, ignoring the importance of revenue in the global performance of hotels. As pointed out by A. G. Assaf and Josiassen (2016), studies on hotel efficiency should use the Bayesian approach rather than the traditional maximum likelihood method. This procedure would provide a more accurate estimate of hotel performance. The goal of this article is thus to help fill the gap in the literature concerning the use of the Bayesian approach in the estimation of profit efficiency and its determinants in the hotel industry.

Method

The Stochastic Profit Frontier

Since the SFA was introduced by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van den Broeck (1977), it has been widely used in the literature to estimate firm-specific efficiency. The main advantage of this model is that it allows the existence of a composite error: That is, a company can deviate from its optimal frontier due to random perturbations and its own inefficiency. In this way, as opposed to the DEA, random perturbations do not distort the measurement of inefficiency.

According to Berger and Mester (1997) and Humphrey and Pulley (1997), the profit function used in the study is termed the alternative profit function. This function takes the output quantities as given and allows the output prices to vary freely. In this manner, it takes into account differences in the quality of outputs and the possible existence of companies that have certain market power for setting the prices of the outputs. This alternative profit function can be expressed as

$$\begin{gathered}\pi_{it} = \beta_0 + \mathbf{x}'_{it}\beta + v_{it} - u_{it} \\ i = 1,\ldots,N \text{ companies}; t = 1,\ldots,T \text{ periods},\end{gathered} \tag{1}$$

where π_{it} is ln of the profits of the company i during the period t, β_0 is a scalar intercept, $\mathbf{x}'_{it}$ is the vector of explicative variables (input prices and output quantities), $\boldsymbol{\beta}$ represents the vector of parameters to be estimated, v_{it} is the identical and independent random error distributed as $v_{it} \sim N(0, \sigma_v^2)$ and independent of u_{it}, and u_{it} represents profit inefficiency, which is considered to be independently and identically distributed following a one-sided distribution, to confirm that the inefficiency is not negative. The most common asymmetric distributions proposed in the literature are (a) exponential[2] (Aigner et al., 1977; Meeusen & Van den Broeck, 1977), (b) truncated normal (Stevenson, 1980), and (c) gamma (Greene, 1990).

An important issue, once the efficiency has been estimated, is to determine what is affecting the performance of the hotels. Some studies (e.g., De Jorge & Suárez, 2014; Parte-Esteban & Alberca-Oliver, 2015) have tried to answer this question by regressing the estimated efficiency against different characteristics of the hotels. This two-stage approach has been criticized by Wang and Schmidt (2002) and Rahman (2003), because this procedure is inconsistent with respect to the assumption that inefficiencies are identically distributed with one-sided error terms (Coelli, 1996). In this approach, the first step involves the estimation of the stochastic frontier and the prediction of the efficiency and, in the second step, a regression model is specified to predict the factors that affect the inefficiency. This procedure contradicts the assumption of an identically distributed one-sided error term in the stochastic frontier (Battese & Coelli, 1995).

The present study used the model proposed by Battese and Coelli (1995), which allows estimating the efficiency and its determinants by means of a one-stage estimation procedure. For this reason, it is considered that the term u_{it} depends on vectors of observed covariates (z'_{it}), in such a way that, in the case of a truncated normal distribution, inefficiency is expressed as

$$\begin{gathered}u_{it} \sim N^+\left(\mu_{it}, \sigma_u^2\right) \\ \mu_{it} = \delta_0 + z'_{it}\ \delta,\end{gathered} \tag{2}$$

where δ_0 is a scalar intercept and $\boldsymbol{\delta}$ is the vector of coefficients to be estimated, which will determine the effect that each covariate has on profit efficiency in the hotels.

After the stochastic frontier has been estimated, the profit efficiency of the hotel i during the period t is defined as $PE_{it} = \exp(-u_{it})$, $0 < PE_{it} < 1$. The hotels with efficiency close to 1 are considered the most efficient with respect to profits. It should be noted that if π_{it} is the ln of the profit of a hotel, the hotels with losses generate a problem in the estimation of the stochastic frontier. The logarithm of a negative number is not defined and, therefore, it would not be possible to estimate profit efficiency in the companies with losses. Traditionally, to avoid the removal of the companies with negative results from the samples, it has been chosen to rescale the variable π_{it} so that $\pi_{it} \in \mathbb{R}^{+}$. The most widely used method has added the absolute value of the largest loss observed in the sample plus 1 ($\pi + |\pi^{min}| + 1$) to the profits of each company.

As pointed out by Bos and Koetter (2009), however, the effect that this manipulation has on the structure of the error term cannot be controlled. For this reason, we used the alternative solution proposed by these authors. We created a new independent variable called the negative profit indicator (NPI). This variable takes value 1 for those hotels with $\pi_{it} \in \mathbb{R}^{+}$ and is equal to the absolute value of the results of hotels with $\pi_{it} \in \mathbb{R}^{-}$. Simultaneously, π_{it} takes value 1 for those companies with $\pi_{it} \in \mathbb{R}^{-}$ and the corresponding value when $\pi_{it} \in \mathbb{R}^{*}$. Bos and Koetter (2009) demonstrate that this method improves the discriminatory power of the model and the rank stability of efficiency scores.

Bayesian Estimation

The estimation of the stochastic frontier is normally carried out using maximum likelihood techniques (A. G. Assaf & Barros, 2011); however, the use of Bayesian techniques is gaining greater prominence as an attractive alternative to the frequentist approach (Coelli et al., 2005). The pioneers in using Bayesian inference in stochastic frontier models were Van den Broeck, Koop, Osiewalski, and Steel (1994). These authors highlight how this technique allows exact finite-sample results to be obtained, easily incorporating constraints in the model, and determining the formal specification of parameters and model uncertainty.

The main advantage of the Bayesian inference compared with the sampling theory is that it allows the inclusion of prior information about the vector of parameters to be estimated ($\theta = [\theta_1, \ldots, \theta_k]$) through a probability density function ($p[\theta]$), that is, previous knowledge or results of previous studies can be introduced in the research model. Once the data have been observed, the information is summarized in the known likelihood function ($L[y \mid \theta]$). The Bayes's theorem combines the two types of information in the following way:

$$p(\theta \mid y) \propto L(y \mid \theta)\, p(\theta), \tag{3}$$

where $p(\theta \mid y)$ is the posterior probability density function and $\propto$ means that "it is proportional to." Therefore, the posterior probability density function is proportional to the likelihood function and the prior probability density, that is, the posterior distribution includes all the information about the vector of parameters ($\theta = [\theta_1, \ldots, \theta_k]$) contained in the prior and data. The posterior distribution allows inferences to be made about the unknown parameters (Koop, 1994). In this way, the results are presented in terms of probability density functions, which allow probability statements to be made about hypotheses, models, and parameters (Coelli et al., 2005).

To obtain the posterior distribution ($p[\theta \mid y]$), it is necessary to specify the likelihood function ($L[y \mid \theta]$) and the prior distribution ($p[\theta]$). The likelihood function of a stochastic frontier model, with different distributions of the error term, has been provided by various authors in the literature (Kumbhakar & Lovell, 2003).

We follow the choice of prior information about the parameters, as proposed by Griffin and Steel (2007). The noninformative distributions of the parameters of the stochastic frontier considered a priori independent are as follows:

$$\beta_0 \sim N\left(0, 10^{-6}\right)$$
$$\beta \sim N\left(0, 10^{-6}\right)$$
$$\sigma_v^2 \sim Ga\left(10^{-3}, 10^{-3}\right),$$

where $N(\rho, \delta^2)$ represents a truncated normal distribution with mean ρ and variance δ^2 and $Ga(a, b)$ is a gamma distribution with mean a/b and variance a/b^2.

As previously mentioned, the inefficiency u_{it} follows a one-sided distribution and the distributions most used in the literature are truncated normal, exponential, and gamma. The choice of a suitable distribution for u_{it} is a critical issue when the main goal is to obtain the inefficiency (Ehlers, 2011), and therefore, in the present study, we used three different models considering each of these distributions, so that we could determine which distribution is most appropriate for the term u_{it}:

1. We consider that profit inefficiency (u_{it}) follows an exponential distribution, so that $u_{it} \sim (\lambda)$, where it is assumed that inefficiency depended on covariates with $\lambda = \exp(\delta_0 + z'_{it}\ \delta)$. We attribute a prior $\exp(\delta) \sim \text{Exp}(-\log r^*)$, where r^* is the prior median efficiency in the sector ($r^* \in [0, 1]$). Given that studies of profit efficiency in the hotel industry are scarce and, therefore, there is insufficient evidence of the profit median efficiency, we considered that $r^* \sim Unif(0.3, 0.9)$.
2. We assume that profit inefficiency (u_{it}) follows a truncated normal distribution, so that $u_{it} \sim N+(\mu_{it},$

σ_u^2), with $\mu_{it} = \delta_0 + z'_{it}\ \delta$. We attributed the prior $\delta \sim N(0,\ \sigma_u^2)$.

3. We consider that inefficiency follows a gamma distribution $u_{it} \sim Ga(\phi, \lambda)$, where $\lambda = \exp\ (\delta_0 + z'_{it}\ \delta)$. It is assumed that $\phi^{-1} \sim Ga(d_1, d_1 + 1)$, which implies that ϕ has a prior mode of one. Griffin and Steel (2004) suggest that $d_1 = 3$. In this case, $\exp\ (\delta) \sim Ga(\phi, -\log r^*)$.

Once the prior distributions and the likelihood function are specified, it is possible to obtain the posterior distributions of the model. These distributions are available in Coelli et al. (2005). The use of Bayesian techniques involves the evaluation of complex integrals, which can be estimated using the Markov Chain Monte Carlo (MCMC) method, and in particular, the Gibbs sampling algorithm proposed by Koop, Steel, and Osiewalski (1995), which is the most common in the literature (Griffin & Steel, 2007; Huang, 2004; Kumbhakar & Tsionas, 2005; Tsionas, 2002).

Data and Selection of the Variables

The data used in the present study to estimate the stochastic profit frontier were obtained from the Iberian Balance Sheets Analysis System (SABI) and the Alimarket database. We selected all those companies belonging to Category 551, that is, hotels and similar accommodations, in the National Classification of Economic Activities (CNAE-2009), which had all the data needed available. Companies whose main activities were not exclusively the management and operation of a hotel establishment were excluded from the study. As a result, the final sample include the balanced data of 312 hotel companies in Spain from 2010 to 2014 (1,560 observations).

With respect to the selected variables, as previously mentioned, the profit function represents the relationship between profit, input prices, and output quantities. The selection of these variables was performed taking into account the availability of data and the previous literature for the sector. The dependent variable of the stochastic frontier of profits (π) is defined as earnings before interest and taxes (EBIT).

We specified two variables relating to output, namely, (a) net revenues (x_1), which included the revenue obtained through the operation of the main activity of the hotels (i.e., revenue of room, food and beverage); and (b) other incomes (x_2), which represented the income from other activities. These variables have been used to calculate the efficiency in the hotel industry by Hwang and Chang (2003), Chen (2007), and Pérez-Rodríguez and Acosta-González (2007), among others.

As the prices of the inputs are not directly observable, they were estimated through proxy variables from the available information. The prices of the specified inputs were as follows:

1. Price of labor (w_1): Calculated as the ratio between labor costs and the number of full-time annual equivalent employees (A. G. Assaf & Cvelbar, 2011; Chen, 2007; Pérez-Rodríguez & Acosta-González, 2007).
2. Price of materials (w_2): ratio between cost of materials (i.e., total food, beverage, and room expenditure) and operation incomes. Among the authors who have considered the materials as input are Chen (2007), Hu, et al. (2010), and A. G. Assaf and Cvelbar (2011).
3. Price of other operations costs (w_3): ratio between other operations costs (total expenditure on administration, marketing, supplies, and rentals) and the income from operations. Hu et al. (2010) consider that it is necessary to include other costs of operations as input.
4. Price of the capital (w_4): resulting from the ratio between assets depreciation (material and nonmaterial) and total assets (A. G. Assaf & Cvelbar, 2011; Pérez- Rodríguez & Acosta-González, 2007).

Table 1 provides the descriptive statistics of the variables that make up the profit frontier. Note that all the variables were deflated according to the index of prices in the sector calculated as 2011 = 100 (Spanish National Statistics Bureau (INE), 2016).

We specified five different determinant factors of profit efficiency concerning the inefficiency function: (a) affiliated versus independent, (b) size of the hotels, (c) location, (d) customer satisfaction, and (e) occupancy rate of bed-places by region. As indicated by A. G. Assaf and Josiassen (2016), few studies have discussed and analyzed the determinants of efficiency. The present study provided evidence, not only about the efficiency of the industry, but also which and how certain variables affect inefficiency. These findings can provide greater understanding for hotel managers at the time of developing and implementing business policies and strategies.

The first determinant that we considered in our study was "affiliated versus independent." We used this variable to assess how profit efficiency is affected by the fact that the hotels belonged to a hotel chain or, on the contrary, were independent hotels. To that end, we define the dummy variable z_1, to which we attribute value 1 if the property of the hotel is independent, or value 0 if the hotel belongs to a hotel chain. As far as we know, there are no previous studies assessing the effect of affiliated versus independent on profit efficiency.

The second explanatory factor that we have specified is the variable "size." We use this factor to assess whether the size of the hotels affects their levels of profit efficiency. This information could encourage hotel managers to implement expansion strategies, if it is associated with greater efficiency or, on the contrary, with a policy to reduce their

Table 1.
Descriptive Statistics of the Data (2010-2014).

Variable	Description	Minimum	Maximum	*M*	*SD*
π*	EBIT	−10,699.30	38,846	664.73	2,250.90
x_1^*	Net revenues	449.70	69,092.47	6,873.88	8,340.88
x_2^*	Other incomes	0	12,623.04	181.29	734.30
w_1^*	Price of labor	7.23	57.15	28.66	5.39
w_2	Price of materials	0.005	0.53	0.18	0.08
w_3	Price of other operations	0.048	0.77	0.28	0.11
w_4	Price of the capital	0.001	0.31	0.06	0.05

Note. EBIT = earnings before interest and taxes.
*In thousands of Euros.

size. To measure the variable "size" (z_2), we categorized hotels into two categories. Hotels with less than 300 rooms are considered small, whereas medium and large hotels have more than 300 rooms. In this manner, a dummy variable z_2 was created that takes a value of 1 if the hotel has more than 300 rooms and 0 otherwise (A. G. Assaf & Agbola, 2011; Shang, Hung, Lo, & Wang, 2008).

The third determinant of hotel efficiency that is specified in this study is "location." This variable has been widely recognized as one of the essential attributes for hotel establishments (Balaguer & Pernías, 2013; Lado-Sestayo, Otero-González, Vivel-Búa, & Martorell-Cunill, 2016). The economic literature generally recognizes the importance of a company's location to innovate, reduce costs and, as a result, be more efficient. To study whether the profit efficiency of hotel companies is influenced by the location of their establishments, we define the variable "location" as a dummy variable z_3 that has a value of 1 if a hotel is located in a resort area and 0 otherwise.

The fourth determining factor of hotel efficiency that is specified is "customer satisfaction." It is expected that greater customer satisfaction will have a positive effect on efficiency because it favors a greater market share, reduced price elasticity and reduced costs, especially those associated with attracting new customers (Chien, Chang, & Su, 2003). Despite its importance, previous research does not yet provide evidence that customer satisfaction is a determinant of hotel efficiency. However, A. G. Assaf and Magnini (2012) did determine the importance of this factor, including it as an output variable in their study about hotel efficiency. We define the variable "customer satisfaction" (z_4) as the natural logarithm of the average rating left by clients in different booking websites. The "occupancy rate of bedplaces by region" is also studied. This variable sought to analyze whether the Spanish region in which a hotel establishment is located can influence the hotel's level of efficiency. To measure this variable (z_5), the National Statistics Institute database is used.

Finally, we include the variable "tendency" to assess whether profit efficiency remained constant or varied during the study period. In this way, we checked whether the hotels tended to be more or less efficient over time or, conversely, if the efficiency was not affected by the course of time. The values of this variable were 1 in 2010; 2 in 2011; 3 in 2012; 4 in 2013; and 5 in 2014. Table 2 shows the descriptive statistics of the determinant factors and tendency.

Empirical Results

To estimate the stochastic profit frontier, it is necessary to determine an appropriate functional form and thus avoid possible errors of an incorrect specification. The Cobb–Douglas and the translog functional form have been most commonly used in the literature on efficiency. We use the deviance information criterion (DIC), proposed by Spiegelhalter, Best, Carlin, and Van der Linde (2002), to compare the forms and select the most appropriate. The model with a lower DIC is considered the best-fit model. We use the WinBUGS software to obtain the DIC of the two models. The results indicate how the translog functional form (DIC = 3,400.54) fits better to the study sample than the Cobb–Douglas function (DIC = 3,649.79).

The same criterion is used to choose the most appropriate distribution of the term inefficiency (u_{it}). In Table 3, we compare the DIC values obtained for the three different distributions of u_{it}: truncated normal, gamma, and exponential. It is demonstrated that the model which considers that inefficiency follows an exponential distribution seems to fit better.

Applying the restrictions of linear price homogeneity, the final model is expressed as follows:

$$\ln\left(\frac{\pi_{it}}{w_{4,it}}\right) = \beta_0 + \sum_{j=1}^{2}\beta_j \ln x_{j,it} + \sum_{s=1}^{3}\alpha_s \ln\left(\frac{w_{s,it}}{w_{4,it}}\right) + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2}\beta_{j,k}\ln x_{j,it}\ln x_{k,it} + \frac{1}{2}\sum_{s=1}^{3}\sum_{r=1}^{3}\alpha_{s,r}\ln\left(\frac{w_{s,it}}{w_{4,it}}\right)\ln\left(\frac{w_{r,it}}{w_{4,it}}\right) + \sum_{j=1}^{2}\sum_{s=1}^{3}\rho_{j,s}\ln x_{j,it}\ln\left(\frac{w_{s,it}}{w_{4,it}}\right) + \theta \ln \mathrm{NPI}_{it} + v_{it} - u_{it}. \quad (4)$$

Table 2.
Descriptive Statistics of the Determinant Factors and Tendency (2010-2014).

Variable	Description	Minimum	Maximum	*M*	*SD*
z_1	Affiliated vs. independent	0.0	1.0	0.48	0.5
z_2	Size	0.0	1.0	0.2821	0.4501
z_3	Location	0.0	1.0	0.625	0.4843
z_4	Customer satisfaction	6.4	9.4	8.28	0.5152
z_5	Occupancy rate of bed-places by region	0.2337	0.7491	0.5650	0.1355
z_6	Tendency	1.0	5.0	3.0	1.41

Table 3.
DIC Values for Different Distributions of the Term Inefficiency.

Distributions of the Term Inefficiency	DIC
Truncated normal	4,655.35
Gamma	3,390.13
Exponential	3,354.85

Note. DIC = deviance information criterion.

Once the stochastic frontier is determined, we use Gibbs sampling to estimate it. A total of 50,000 interactions were generated, 5,000 of which were discarded to avoid the sensitivity of initial values and ensure convergence. The subsequent results (posterior means and posterior *standard deviations*) are illustrated in Table 4. It can be seen that the standard deviations of the majority of the parameters are low, which provides additional confirmation of the model convergence (A. G. Assaf & Magnini, 2012). In addition, most of the coefficients of the variable "outputs" and "price of the inputs" are statistically significant (17 out of 22 parameters), thus showing the appropriate selection of these variables.

Profit efficiency varied from 48.08% in 2010 to 55.53% in 2014, with a mean efficiency of 51.48% (Table 5). The hotel industry is therefore wasting 48.52% of its potential profits. That is, if the profits of a hotel are on average 664,734 Euros (Table 1), the hotels could increase their profits by approximately 626,513 Euros.

The hotels also demonstrate a wide range of profit efficiency, from a minimum of 10.71% up to a maximum of 91.51%, corresponding to the hotel with the greatest profit efficiency in the sample. This high dispersion is not surprising if we compare these results with the results obtained for profit efficiency in other sectors (Aiello & Bonanno, 2013; Berger & Mester, 1997; Fitzpatrick & McQuinn, 2008; Rahman, 2003).

Even though the assessment of cost efficiency is not the object of the study, to perform a comparative analysis with profit efficiency, the former was estimated following the same method. The average level of efficiency of costs is 80.69%, which is substantially higher than the level of profit efficiency. Less than 20% of the costs could thus be reduced in the industry without having to decrease the level

Table 4.
Posterior Statistics of the Stochastic Frontier Model.

Parameters	Posterior *M*	*SD*
β_0	23.44***	5.964
β_1	1.035*	0.642
β_2	0.1835	0.3093
α_1	−11.22***	2.032
α_2	3.63***	0.9209
α_3	8.414***	1.183
β_{11}	−0.2294***	0.06908
β_{12}	−0.01635	0.02518
β_{22}	0.02762*	0.01798
α_{11}	1.942***	0.3925
α_{12}	−0.7871***	0.1764
α_{13}	−1.342***	0.243
α_{22}	0.3608***	0.09277
α_{23}	0.4384***	0.1125
α_{33}	1.167***	0.1964
ρ_{11}	0.3752***	0.1135
ρ_{12}	0.0261	0.06222
ρ_{13}	−0.2431***	0.08151
ρ_{21}	−0.0000854	0.05747
ρ_{22}	0.01294	0.03053
ρ_{23}	−0.0661*	0.04435
θ	−0.9851***	0.006247
σ^2	0.273***	0.02446

*Significant: 10% ($p < .10$). **Significant: 5% ($p < .05$). ***Significant: 1% ($p < .01$).

Table 5.
Mean Profit Efficiency.

Years	2010	2011	2012	2013	2014	*M*
PE	48.08%	51.78%	52.92%	54.34%	55.53%	51.48%
SD	0.1680	0.1709	0.1683	0.1715	0.1672	0.1752

Note. PE = profit efficiency.

Table 6.
Posterior Statistics of the Inefficiency Model.

Parameters	Posterior *M*	*SD*
δ_0	−0.7547	0.7853
δ_1	−0.02909*	0.06469
δ_2	0.1688***	0.07839
δ_3	0.104**	0.07668
δ_4	0.2103*	0.3718
δ_5	0.1598*	0.277
δ_6	0.05897***	0.01996

*Significant: 10% ($p < .10$). **Significant: 5% ($p < .05$). ***Significant: 1% ($p < .01$).

of services. As previously noted, almost 50% of the potential profits are being wasted by the hotels. This demonstrates that profit inefficiency is more significant than the inefficiency of costs and shows the importance of the inefficiencies of incomes.

The statistics for the covariates affecting inefficiencies are shown in Table 6. Affiliated versus independent was tested in the two groups, that is, independent hotels and those belonging to hotel chains. The results show the significant effect that operation types have on profit efficiency in the hotel industry (δ_1). The hotels that belong to hotel chains reach higher average levels of efficiency than independent hotels. One possible explanation for this is that hotel chains tend to centralize management operations, which allows a more optimal use of resources, facilitates a more advantageous position with respect to suppliers, and uses a common booking system.

These situations lead to initiatives that take advantage of possible synergies between hotels of the same chain (Barros & Dieke, 2008; Hwang & Chang, 2003; Such-Devesa & Mendieta-Peñalver, 2013).Hotel chains also offer more standardized products, which customers identify with a brand and/or logo, thus reducing tourist uncertainty, because they know beforehand the expected levels of quality (Cerro, 1991).

In this way, search costs are reduced for customers because they associate the image and quality of a hotel with the rest of the hotels belonging to the same chain. At the same time, the chains also have greater capacity to obtain bank credit. They are also able to deal with the purchase of facilities and modern machinery with increased capacity and performance. These resources allow these companies to carry out training courses for their employees, which help improve their professional skills and specialization. As a result, the hotels reduce their labor costs (Rodríguez, 2002).

The coefficient of the variable "size" (δ_2) is statistically significant, which indicates that the dimension of the hotels (measured by the number of rooms) has a significant effect on profit efficiency. In addition, the positive sign indicates a positive correlation between hotel size and profit efficiency levels. In general, the relationship between size and efficiency is a controversial topic in the hotel industry (A. G. Assaf, Barros, & Josiassen, 2010). Hwang and Chang (2003) and Chen (2007) conclude that size is not an important determinant of hotel cost efficiency, whereas Barros (2006), Barros and Dieke (2008), and A. G. Assaf et al. (2010) claim that it influences hotel efficiency. Specifically, these authors conclude that larger hotels are more cost efficient than smaller hotels.

On one hand, this positive relationship is explained by the economies of scale associated with the use of fixed factors that larger companies can take advantage of (Bannock, 2005). In addition, the average costs of marketing, such as advertising and promotion, are lower because they are distributed among a larger volume of services (A. G. Assaf, Josiassen, Mattila, & Cvelbar, 2015). On the other hand, the size of hotel establishments is also expected to affect their pricing policy. That is, the proportion of hotel revenue is similar to the proportion of the total number of hotel rooms (Pine & Phillips, 2005). Kim, Cho, and Brymer (2013) also find a positive relationship between the dimension and the average daily rate.

Third, the coefficient (δ_3) is also statistically significant and positive, demonstrating that hotels located in resort areas exhibit higher profit efficiency than those located in urban markets. This result is consistent with those obtained by Bernini and Guizzardi (2010), Chen (2007), Hwang and Chang (2003) and Shang, Wang, and Hung (2010) for the case of cost efficiency.

Online reviews, through the variable "customer satisfaction," have a significant effect on the profit efficiency of hotels. The coefficient of this variable (δ_4) has a positive sign, indicating that higher online ratings by customers are associated with higher efficiency. As stated by Sparks and Browning (2011), online reviews have a significant influence on customers' purchasing decisions, especially on the propensity to book a hotel room. Potential customers use online reviews as a means to reduce risk and uncertainty in purchasing decisions (Chen, 2008) because the quality of services is usually unknown before consumption. According to Gretzel and Yoo (2008), three out of four customers consider online consumer reviews when planning their trips. Furthermore, Ye, Law, and Gu (2009) demonstrate that positive online reviews significantly increase the number of hotel bookings.

The variable "occupancy rate of bed-places by region" has a positive and significant coefficient ($\delta 5$), indicating an important and positive influence on profit efficiency. This result indicates that hotels located in the Spanish regions with a greater occupancy rate profit from a higher level of efficiency, suggesting that the profit efficiency of hotels is associated with regional tourist flow.

Finally, it is worth mentioning that profit efficiency varies over the course of time. Taking into account the sign of the coefficient of the variable "tendency"(δ_3), efficiency tended to grow throughout the period of analysis (2010-2014). This could be explained by the increased competitiveness of the sector, which forced the managers of the hotels to carry out strict control of incomes and costs.

Conclusions and Implications

The measurement of the performance of hotel companies is relevant, because it allows an assessment of the greater or lesser success of management strategies to set their competitive position in the market. The globalization of the economy and the increased competition in the hotel industry are also forcing hotels to be increasingly efficient to survive. Profit efficiency is the concept that best evaluates the global performance of a company, as it determines the errors of outputs and inputs.

The present study estimates profit efficiency and its determinants in the hotel industry in Spain using the Bayesian SFA. This model has many advantages when compared with the traditional frequentist approach (A. G. Assaf & Josiassen, 2016) and provides more accurate estimates of efficiency. The results show that the mean profit efficiency in the hotels in Spain is 51.48%, which is substantially lower than the efficiency of costs (80.69%). This result is similar to that found in other industries (e.g., Aiello & Bonanno, 2013; Berger & Mester, 1997; Fitzpatrick & McQuinn, 2008; Rahman, 2003) and corroborates the importance of inefficiencies on the revenue side of hotel activity, demonstrating that to assess efficiency, it is insufficient to only measure cost efficiency; rather, it is also necessary to consider profit efficiency.

Likewise, the high dispersion of profit efficiency (approximately 17 percentage points) indicates that in the industry, hotels that are earning significantly more or less than the sector average coexist. This corroborates our hypothesis that a certain market power exists in the hotel industry in terms of price-fixing services. In other words, the hotel industry is not a perfectly competitive sector, which could partially explain the strong inefficiencies found. Profit efficiency also increased during the years of study from 48.08% in 2010 to 55.53% in 2014. This result reflects the good reaction of the hotel industry to the recent economic crisis in terms of both costs and revenues. The results also reveal that independent hotels are less efficient than those that belong to a hotel chain, thus indicating that the hotel chain system has a positive effect on efficiency. Similarly, the greater the size is of the hotel, the greater the profit efficiency levels, owing to the use of economies of scale and greater negotiating power. Hotels located in resort areas and regions with a high occupancy rate are also more profitable. Finally, it is demonstrated that customer satisfaction has a positive effect on the profit efficiency of hotels.

These findings have important implications for formulating the strategies of hotel management. First, managers should focus their efforts on improving revenue efficiency, formulating strategies to offer higher quality services and higher margin services. Second, the efficiency of chain hotels is higher than that of independent hotels. In this way, independent hotels should promote collaborative strategies for supplying materials and the marketing of their services. Third, implementation of growth policies in hotel establishments will have a positive effect on efficiency. Fourth, location represents a substantial strategic variable for reducing hotel inefficiencies. Finally, public authorities should implement policies aimed at improving the quality of infrastructure. The quality of infrastructure is directly correlated with the degree of attraction of a destination and with tourists' intention to return to a particular area (Beerli & Martin, 2004).

Acknowledgements

The authors thank the chief editor of this journal for their valuable comments. The authors are also very grateful to Francisco José Vázquez Polo and Miguel Ángel Negrín Hernández (University of Las Palmas de Gran Canaria) for their excellent research assistance. All errors are the authors' responsibility.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, or publication of this article.

Notes

1. See A. G. Assaf and Josiassen (2016) for a detailed review of frontier studies in the hotel industry.
2. The exponential distribution is a particular case of the gamma distribution when the shape parameter is equal to 1.

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