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Impact of quality on estimations of hotel efficiency

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HIGHLIGHTS

- The hotel industry is operating with substantial profit inefficiencies.
- The quality of hotel services has a significant impact on overall efficiency.
- Profit efficiency is more relevant than cost efficiency when output quality differs.

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ABSTRACT

This paper provides empirical evidence on the impact of output quality on hotel efficiency. It demonstrates how ignoring quality can lead to erroneous efficiency estimates. The study uses stochastic frontier methodology and the model proposed by Battese and Coelli (1995) to estimate the efficiency of 838 hotels in Spain in the period 2009–2013. The key advantage of this methodology is its ability to estimate efficiency and identify factors that explain differences in efficiency in a single-stage sampling procedure. Estimates of cost efficiency, which only include the costs of higher quality, are compared to those of profit efficiency, which not only consider costs but also the revenues generated by higher quality. Results show that quality has a negative impact on cost efficiency and a positive one on profit efficiency. Thus, hotel management should implement strategies that increase the value of their services as a way to achieve sustainable competitive advantages.

1. Introduction

In the last decade, numerous studies have been published on efficiency in hotel companies (Assaf & Magnini, 2012; Barros, 2005; Barros, Dieke, & Santos, 2010; Bernini & Guizzardi, 2010; Chen, 2007; Fernández & Becerra, 2015; Hadad, Hadad, Malul, & Rosenboim, 2012; Jorge & Suárez, 2014; Parte-Esteban & Alberca-Oliver, 2015; Such-Devesa & Mendieta-Peñalver, 2013; Untong, Kaosa-Ard, Ramos, & Rey-Maquieira, 2011; Wang, Hung, & Shang, 2006a, 2006b; Wang, Lee, & Wong, 2007; among others). All these studies have followed a standardized methodology and conceptual framework focusing on minimizing hotel costs (cost efficiency) under given production conditions. From our point of view, the concept of cost efficiency presents an important limitation, since it does not capture differences in the service quality of hotels. This omission can lead to erroneous efficiency estimates.

Quality has become a key factor as a differentiator to succeed and survive in highly competitive sectors such as the hotel sector (Akbaba, 2006; Chen, 2013; Cheng & Rashid, 2013). Quality ensures loyalty among customers, attracts new ones and increases reputation and revenue (Berry, Bennett, & Brown, 1989; Chen, 2013; Saleem & Raja, 2014).[1] In this sense, a correct measure of efficiency should take into account both output quantity and their quality (Assaf & Magnini, 2012).

If quality differences (i.e. vertical differentiation) in hotel services are not taken into account and given that higher quality implies higher costs, considering these higher costs as inefficiencies would lead to errors in efficiency estimates. These errors would result from the unmeasured differences in the quality of the hotel services. It should be noted that quality does not just mean higher costs but also higher revenues due to the market power of pricing,

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[1] For a thorough study of the importance of quality in the provision of hotel services, consult Callan and Kyndt (2001); Min, Min and Chung (2002); Tsaur and Lin (2004); Ladhari (2009); Mohsin and Lockyer (2010); Marković and Raspor Janković (2013) and Minh, Ha, Anh and Matsui (2015).

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which is derived from specialization or from a different output composition. This higher revenue can offset higher costs. In this way, measures of cost inefficiency can be contaminated by the composition of the output, since higher quality output could be more expensive but not necessarily more inefficient (Maudos, Pastor, Perez, & Quesada, 2002). By contrast, the concept that better reflects the effects of quality on both costs and revenue and their interaction is profit efficiency, as this concept is based on the widely accepted economic objective of profit maximization.

Profit efficiency captures unmeasured differences in output quality, since it considers both increased costs and increased revenues resulting from higher quality. If the market is competitive and customers are willing to pay for better quality services that some hotels offer, these hotels could obtain higher revenues, which would compensate for the extra quality costs. Therefore, given the gaps in the literature on hotel efficiency regarding differences in service quality, the objective of this paper is to estimate profit and cost efficiencies and to investigate the impact of quality on the overall efficiency of hotels.

This paper contributes to the existing literature on hotel efficiency in two ways. First, cost efficiency and profit efficiency are estimated for a sample of 838 hotels in Spain between 2009 and 2013. As mentioned previously, numerous studies have focused on estimating cost efficiency in the hotel sector. However, there have been very few on profit efficiency, even though empirical evidence in other sectors has shown that profit inefficiencies are much more important than cost inefficiencies. Second, quality as a determinant of inefficiency is analysed using a stochastic frontier approach (SFA) and the model of Battese and Coelli (1995). This methodology has the advantage of estimating the frontier function and inefficiency effects function in a single-stage sampling procedure, which allows efficiency to be estimated more accurately.

The rest of the paper is structured in the following way. The next section briefly reviews the literature on efficiency in the hotel industry. In section 3, the importance of quality as a determinant of efficiency is discussed theoretically and the working hypotheses are formulated. The research methodology is specified in section 4 and, subsequently, the data and the variables used are presented. The empirical results are given in section 6. Finally, the key findings and implications of the study are discussed.

2. Literature review

The concept and measurement of efficiency are very important in economics and have been analysed widely in practically all sectors. The hotel industry is no exception, and the literature on efficiency and productivity in this sector has developed greatly in the last decade, mainly due to the difficulties and challenges it has faced (Assaf & Magnini, 2012). This development has mainly followed two methodologies: Data Envelopment Analysis (DEA) and the Stochastic Frontier Approach (SFA).

DEA was first introduced by Charnes, Cooper, and Rhodes (1978). It is the most commonly used technique among the non-parametric and deterministic methods. The optimal frontier, which is obtained by linear programming methods, “envelops” inefficient companies. The distance between these companies and the optimal frontier is considered as inefficiency, though this method does not take into account possible random errors. This technique is used by authors such as Barros (2005); Hadad et al. (2012); Jorge and Suárez (2014); Fernández and Becerra (2015); Parte-Esteban and Alberca-Oliver (2015) and Wang et al. (2006a, 2006b), among others.

On the other hand, the SFA model is a parametric methodology, whereby a company is considered to be inefficient if it deviates from its optimal frontier. This model has the advantage, compared with DEA, of allowing decomposition of the error into a random part and an inefficient one. The SFA methodology has also been used by many authors to estimate efficiency in the hotel industry (Anderson, Fish, Xia, & Michello, 1999; Assaf & Magnini, 2012; Barros, 2004; Barros et al., 2010; Bernini & Guizzardi, 2010; Chen, 2007; Wang et al., 2007).

Virtually all these studies estimate cost efficiencies by specifying output variables like total revenue, sales, number of rooms, market share, guest numbers, nights stayed or some variants thereof. Only the study by Assaf and Magnini (2012) uses, in addition to others, customer satisfaction as an output to include the quality of hotel services. These authors found that the ranking of hotel efficiency changed depending on whether or not customer satisfaction was included as an output in the model.

In addition, authors like, Abrate, Capriello, and Fraquelli (2011); Becerra, Santaló, and Silva (2013); Israeli (2002); Núñez-Serrano, Turrión, and Velázquez (2014) and Orfila-Sintes, Crespí-Cladera, and Martínez-Ros (2005) suggest that the quality of hotels could be approximated by the hotel category (number of stars). In this regard, several studies use this variable as an explanatory factor for the possible differences between levels of cost (in)efficiency of hotels without reaching conclusive results. On the one hand, Assaf and Agbola (2011) and Such-Devesa and Mendieta-Peñalver (2013) state that the greater the number of stars, the greater the level of technical efficiency. These authors argue that the highest category hotels are technically more efficient because of the strong pressure to maintain their competitive position and their star ratings.

On the other hand, Tarim, Dener, and Tarim (2000) and Jorge and Suárez (2014) reach the opposite conclusion, arguing that hotels with the highest number of stars compete on differentiation and those with fewer stars on costs. While Oliveira, Pedro, and Marques (2013a) claim that this factor does not explain the levels of technical inefficiency in hotels in Portugal.

However, all these studies only estimate cost efficiencies, which, according to Berger and Mester (1997), do not adequately reflect the differences in the quality of output. Quality involves an extra cost; thus, a hotel that offers higher quality output could be considered to be more inefficient. As discussed in the previous section, higher quality output might be more expensive but not necessarily more inefficient (Maudos et al., 2002).

Only the study by Oliveira, Pedro, and Marques (2013b) analyses the effect that four and five stars have on the efficiency of hotel revenues in Portugal. Their results show that, although five-star hotels tend to achieve higher levels of revenue efficiency than four-star ones, the hotel category is not a significant determinant of that efficiency. These authors justify this tendency arguing that greater differentiation in services attracts customers with greater purchasing power.

To date, we know of no study that analyses how service quality affects the profit efficiency of hotels. Therefore, this paper aims to study the impact of quality on hotel efficiency, from the perspective of both costs and revenue and their interaction.

3. Quality as a determinant of efficiency and hypotheses

The concept of service quality has been widely discussed in the literature as a difficult concept to define and measure. “The evaluation of quality for services is more complex than for products because of their intrinsic nature of heterogeneity, inseparability of production and consumption, perishability and intangibility” (Akbaba, 2006, p. 171). Likewise, the measurement of quality can be understood from two different perspectives: first, an objective one, based on measurable characteristics and, second, a subjective perspective, taking into account customer satisfaction (Núñez-Serrano et al., 2014).

The first perspective, based on objective criteria, has encouraged the emergence of official classification systems that, by means of the number of stars assigned to each hotel, provide information on facilities, services and other measurable characteristics in advance (Núñez-Serrano et al., 2014). The second perspective is related to the concept of customer satisfaction, which is derived from the difference between the expectations of the service and the perception of such services. This perception depends, among other aspects, at the moment when hotel services are provided, causing an additional difficulty to obtain an adequate measure of quality in the hotel industry (Akbaba, 2006; Barrington & Olsen, 1987; Mei, Dean, & White, 1999).

According to the UNWTO (2015), and despite the absence of a standard global classification, the number of stars is a good indicator for customers of the quality of services to be found in a hotel. The minimum requirements for the different categories necessarily imply a positive relationship between the attributes of a hotel and the number of stars. Therefore, the hotel category indicates the level of commitment that a hotel has made regarding the quality of its services, reflecting an excellent approximation of the overall quality of a hotel.

Probably any customer would agree that a five-star hotel is better than a four-star one, and so on, because the higher-rated hotels offer more amenities, more space and more care and attention to detail (Canina, Enz, & Harrison, 2005; Silva, 2015). A good example is the difference in minimum square metres required for each category: five-star hotels must have, for a double room, a minimum of 17 square metres, which descends with decreasing number of stars to 12 square metres for one-star hotels. Another example is the air conditioning in the room, which is only mandatory for hotels with four- and five-star service.

Thus, authors like Abrate et al. (2011), Becerra et al. (2013), Fernández and Marín (1998), Israeli (2002), Israeli and Uriely (2000), Orfila-Sintes et al. (2005), Silva (2015) and Yang and Cai (2016), among others, consider hotel classification to be the most common and accessible indicator to classify the quality of a hotel. Furthermore, Canina et al. (2005) state that the differentiation of higher-rated hotels entails higher costs. Therefore, if quality involves an extra cost, it is expected that the higher the category, the higher the costs for hotels to offer more and better services.

Similarly, other authors have argued that a positive correlation is expected between the hotel quality and the price per room (Briggs, Sutherland, & Drummond, 2007; Bull, 1994; Fernández & Marín, 1998; Israeli, 2002; Wu, 1999). The economic grounds concern the relationship between the higher quality output and the concept of vertical differentiation. Vertical differentiation occurs when certain companies incur extra costs with the aim of improving the willingness of customers to pay for their products (Shaked & Sutton, 1987). Thus, vertical differentiation is generally associated with higher prices (Mazzeo, 2002) and increased market power (Dranove, Gron, & Mazzeo, 2003). Differentiation creates value for consumers; therefore, companies that offer higher quality may require a higher price. Accordingly, the number of stars is an attribute for which consumers are willing to pay a higher price (Silva, 2015).

For these reasons, we believe that the hotel category (number of stars) may represent a good approximation of hotel quality. However, if it is accepted that quality involves an extra cost, the higher-rated hotels may be considered to be more cost inefficient than lower-category ones, when in fact some of these inefficiencies are unmeasured differences associated with service quality. As previously mentioned, the concept that best reflects these higher costs as well as the higher revenues resulting from quality differences in hotel services is profit efficiency.

Hotel category can affect efficiency in two ways: firstly, by reducing cost efficiency and, secondly, by increasing revenue efficiency. It is expected that the extra cost of higher quality could be offset by higher revenue, finally resulting in improved profit efficiency. Therefore, the following working hypotheses are proposed:

H_1: Hotel category is negatively related to the level of hotel cost efficiency.

H_2: Hotel category is positively related to the level of hotel profit efficiency.

4. Methodology for measuring efficiency

The SFA model is a parametric methodology developed simultaneously by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van den Broeck (1977), which estimates the frontier through econometric procedures, allowing the statistical properties of the estimations to be obtained. It assumes that the error term is composite; that is, it is made up of inefficiency and random disturbance. Therefore, it is understood that a company deviates from the frontier as a result of both inefficiency and random fluctuations. These fluctuations reflect the effect of the variables that are not under a company's control.

This research employs the SFA methodology and the model proposed by Battese and Coelli (1995) to estimate the cost and profit efficiencies in the Spanish hotel industry. The model by Battese and Coelli (1995) expands the SFA model and suggests that the determinants of inefficiency can be expressed as a linear function of a set of explanatory variables that reflect the inherent characteristics of a company. The key advantage of Battese and Coelli's model is that it allows an estimation of efficiency for each hotel, and the factors that explain efficiency differences between hotels, in a single-stage sampling procedure. This methodology is a significant step forward in terms of consistency with respect to previous models that first estimate the inefficiency level and, subsequently, using a two-stage procedure, assess a number of explanatory variables in an attempt to explain inefficiency differences between companies. In short, we believe this stochastic model enables the generation of inefficiency levels, while simultaneously enabling these scores to be related to a set of explanatory variables.

Cost efficiency can be defined as the ratio between the minimum costs that can be achieved for a given level of production and the cost of current production. Thus, cost inefficiency tells us how much higher the costs of a company are relative to the minimum cost of producing the same combination of output quantities and input prices, and the difference cannot be explained by random error. The specification of a stochastic cost frontier allows a cost function to be estimated that relates the observed costs for a set of output quantities and input prices, random error and inefficiency. This frontier can be expressed as:

$$C_{it} = f(y_{it}, w_{it})\exp(v_{it})\exp(u_{it}) \quad (1)$$

$i = 1, \ldots, N$ *hotels*; $t = 1, \ldots, T$ *periods*
where C_{it} is the total operating cost of hotel i at time t; f represents the selected functional form; y_{it} is the vector of output quantities; w_{it} is the prices' vector of input variables; v_{it} represents the random error; and u_{it} represents the inefficiencies found. To facilitate the estimation of inefficiency, it is assumed that the random error and inefficiency, v and u, are separable from the remainder of the cost function.

According to Battese and Coelli (1995), we assume that random errors v_{it} are independent and identically distributed as $N(0, \sigma_v^2)$ and independent of u_{it}. Furthermore, u_{it} are non-negative random variables and are assumed to be identical and independently distributed as N (μ, σ_u^2) and truncated at zero; $u_{it} = \delta Z_{it} + \varepsilon_{it}$, whereas Z_{it} is a vector of variables that can affect companies' inefficiency and may even contain a time effect. Additionally, δ is a vector of parameters to be estimated and ε_{it} is a random variable defined as $N(0, \sigma^2)$ truncated such that u_{it} is defined as positive. The likelihood function of this model is given in Battese and Coelli (1993). Likewise, the parameterization proposed by Battese and Corra (1977) is used, whereby σ_v^2 and σ_u^2 are replaced by $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$. The model of Battese and Coelli (1995) allows inefficiency to be explained by a set of variables and introduces the idea that such inefficiency varies between companies and over time.

From expression (1), the measure of cost efficiency (CE) for each hotel in period t is estimated as the ratio between the minimum cost to produce the same amount of output and the same price of inputs and the current cost, that is:

$$CE_{it} = \frac{C^{min}}{C_{it}} = \frac{f(y_{it}, w_{it})exp(v_{it})}{f(y_{it}, w_{it})exp(v_{it})exp(u_{it})} = \frac{1}{\exp(u_{it})} \tag{2}$$

The functional form used in this paper is the translog cost function (Christensen, Jorgenson, & Lau, 1973), which is the most commonly used functional form in this type of study. The translog stochastic cost frontier function, for the case of two outputs and four inputs, can be expressed as:

$$\begin{aligned} \ln(C) = \alpha_0 &+ \sum\nolimits_{j=1}^{2} \alpha_j \ln\left(y_j\right) + \sum\nolimits_{s=1}^{4} \beta_s \ln(w_s) \\ &+ \frac{1}{2}\sum\nolimits_{j=1}^{2}\sum\nolimits_{k=1}^{2} \alpha_{j,k} \ln\left(y_j\right)\ln(y_k) \\ &+ \frac{1}{2}\sum\nolimits_{s=1}^{4}\sum\nolimits_{r=1}^{4} \beta_{s,r} \ln(w_s)\ln(w_r) \\ &+ \sum\nolimits_{j=1}^{2}\sum\nolimits_{s=1}^{4} \rho_{j,s} \ln\left(y_j\right)\ln(w_s) + v_c + u_c \end{aligned} \tag{3}$$

where *ln* is the natural logarithm and α, β and ρ are the parameters to be estimated. To ensure that the cost frontier function is symmetrical and linearly homogeneous in prices, the following restrictions are imposed:

➢ $\alpha_{j,k} = \alpha_{k,j}\ \forall k, j$ y $\beta_{s,r} = \beta_{s,r}\ \forall s, r$ (symmetry).
➢ $\sum_s \beta_s = 1;\ \sum_s^r \beta_{s,r} = \sum_j^s \rho_{j,s} = 0$ (homogeneity of prices).

The function of inefficiency effects with three variables allows the study of the factors affecting hotel inefficiency, which can be expressed as:

$$u_c = \sum\nolimits_k^3 \delta_k Z_k + \varepsilon \tag{4}$$

where Z_k represents the kth explanatory variable of the inefficiency of the companies, δ is the vector of parameters to be estimated and ε is the random error of the model.

To estimate profit efficiency in the hotel sector, this research employs the alternative profit function specified by Berger and Mester (1997), which establishes profit as a dependent variable and uses the same independent variables as the cost frontier (output quantities and input prices). The output variable remains constant, while its price varies freely and affects profit. Profit efficiency is estimated as the ratio between a hotel's current profit and the maximum profit that it could achieve. Efficiency is thus defined simply as the proportion of the maximum profit of a hotel. The alternative profit function can be expressed as:

$$\pi_{it} = f\ (y_{it}, w_{it})\exp(v_{it})\exp(-u_{it}) \tag{5}$$

i = 1, …, N hotels, t = 1, …, T periods
where π_{it} is the profit of hotel *i* at time *t*. In a similar way to the cost frontier function, for the profit frontier function it is assumed that $v_{it} \sim$ iid $N(0,\ \sigma_v^2)$ and $u_{it} \sim$ iid $N(\mu, \sigma_u^2)$ are truncated at zero, where $u_{it} = \delta Z_{it} + \varepsilon_{it}$ and Z_{it} is a vector of variables that can affect companies' inefficiency. Additionally, δ is a vector of parameters to be estimated and ε_{it} is a random variable defined as $N(0, \sigma^2)$ truncated such that u_{it} is defined as positive.

Using expression (5), the profit efficiency (*PE*) for each hotel in period *t* is estimated as the ratio between current hotel profits and the maximum profit, given the same amount of output and the same price of inputs:

$$PE_{it} = \frac{\pi_{it}}{\pi^{max}} = \frac{f(y_{it}, w_{it})exp(v_{\pi it})exp(-u_{it})}{f(y_{it}, w_{it})exp(v_{it})} = \exp(-u_{it}) \tag{6}$$

Nevertheless, the profit function has a drawback when the translog functional form is used, since the dependent variable (profits, π) can take negative values and the logarithm of non-positive numbers cannot be defined. To resolve this problem, numerous papers propose adding to each company's profits the absolute value of the largest loss observed in the sample plus 1 $(\pi + |\pi^{min}| + 1)$ (Aiello & Bonanno, 2013; Berger & Mester, 1997; Fitzpatrick & McQuinn, 2008; Maudos et al., 2002; Pasiouras, Tanna, & Zopounidis, 2009; Sensarma, 2005; Srairi, 2010). Thus, the dependent variable of the company with the highest value of losses is ln 1 = 0. However, the effects that this calculation could have on the structure of the error term have not been studied (Bos & Koetter, 2011).

Bos and Koetter's (2011) recent study provides an alternative solution that incorporates all the available information. These authors propose the creation of an additional independent variable called the negative profit indicator (NPI), which takes values of 1 for those hotels with positive results (π > 0) and is equal to the absolute value of the results when companies incur losses (π < 0). Likewise, the dependent variable (π) takes values of 1 when the results are negative and its corresponding value when they are positive. Thus, both hotels with profits and those with losses are included in the study. This produces an improvement in the stability of the ranking of estimated efficiency, increasing the discriminatory power of the translog profit function (Bos & Koetter, 2011). Therefore, in this paper, the procedure proposed by these authors is employed.

Finally, the translog stochastic profit frontier function, for the case of two outputs and four inputs can be expressed as:

$$\begin{aligned} \ln(\pi) = \alpha_0 &+ \sum\nolimits_{j=1}^{2} \alpha_j \ln\left(y_j\right) + \sum\nolimits_{s=1}^{4} \beta_s \ln(w_s) \\ &+ \frac{1}{2}\sum\nolimits_{j=1}^{2}\sum\nolimits_{k=1}^{2} \alpha_{j,k} \ln\left(y_j\right)\ln(y_k) \\ &+ \frac{1}{2}\sum\nolimits_{s=1}^{4}\sum\nolimits_{r=1}^{4} \beta_{s,r} \ln(w_s)\ln(w_r) \\ &+ \sum\nolimits_{j=1}^{2}\sum\nolimits_{s=1}^{4} \rho_{j,s} \ln\left(y_j\right)\ln(w_s) + \theta\ lnNPI + v_\pi - u_\pi \end{aligned} \tag{7}$$

and the function of the inefficiency effects with three variables:

$$u_\pi = \sum\nolimits_k^3 \delta_k Z_k + \varepsilon \tag{8}$$

The methodology of Battese and Coelli (1995) allows the optimal frontier parameters to be estimated together with the parameters of the explanatory variables of inefficiency, using maximum likelihood techniques. This single-stage procedure is a significant improvement over the widely used two-stage approach, especially as the first stage in the two-stage method is to estimate the frontier, assuming inefficiency to be independent and identically distributed. However, in the second stage, a regression model is specified to predict the explanatory factors of inefficiency, which is a contradiction of the assumption of independence of this term in the stochastic frontier (Battese & Coelli, 1995; Kumbhakar, Ghosh, & McGuckin, 1991; Wang & Schmidt, 2002).

5. Data and selection of variables

To obtain the necessary data, this research used two databases. Firstly, financial and accounting data were obtained from the Iberian Balance Sheet Analysis System (SABI), selecting all companies operating in Spain belonging to category 551: "hotels and similar accommodation" of the National Classification of Economic Activities, CNAE-2009. Subsequently, all the data were checked, eliminating all those companies that were not primarily focused on the management and operation of hotel accommodation. In addition, hotel companies that did not have all the necessary data throughout the analysis period (2009–2013) were excluded. Secondly, the Alimarket database, which contains a census of hotels and the category of each establishment, was used. Finally, the resulting sample was composed of balanced data of 838 hotel establishments from all the regions of Spain in the period 2009–2013 (5 years $\times$ 838 establishments $=$ 4190 observations). Three-star hotels represented 41.41% of the sample, 50.83% were four-star hotels and 7.76% were five-star hotels. Hotels with one and two stars were eliminated from this study with the aim of homogenizing the sample, since the decision-making processes in lower-category hotels differ significantly from those of other hotels. It should also be noted that the Spanish hotel industry is characterized by a greater weight of resort hotels than urban ones.

The selection of input and output variables to estimate the cost and profit frontiers was made based on two criteria: the available data and previous studies in the literature on hotel efficiency. The selected outputs should be a measure of the organization's achievement of goals and objectives (Hwang & Chang, 2003). Therefore, most of the research on hotel efficiency considers hotel revenue as indicative of the output obtained (Anderson et al., 1999; Chen, 2007; Hu, Chiu, Shieh, & Huang, 2010; Hwang & Chang, 2003; Jorge & Suárez, 2014; Pérez-Rodríguez & Acosta-González, 2007; Such-Devesa & Mendieta-Peñalver, 2013). Thus, we specify the following output variables:

- ➢ y_1: *operating revenue*, which includes the revenues that a hotel obtains from its main activities: renting rooms and food and beverage services.
- ➢ y_2: *other operating revenue*, which includes revenues other than those obtained from the main activities: rent from business premises, laundry, beauty and hairdressing salons and casinos, among others.

Inputs are the resources that a hotel uses to obtain its outputs (Wang, Hung, & Shang, 2006b). Although there is less consensus in the economic literature on what the inputs are and how they should be measured, the minimum inputs that are considered necessary for the management of a hotel are materials, employees and physical capital (Hwang & Chang, 2003), to which other operating costs should be added. Input prices are not directly observed and so must be approximated from the available information. It is true that the use of proxy variables to estimate input prices is not advisable, but the information that is currently available does not allow us to improve this estimate. Therefore, the variable input prices used to estimate the cost and profit frontiers are approximate, based on the available information, as detailed below:

- ➢ w_1: *price of labour* is the ratio between personnel costs, including social security costs, and the number of full-time equivalent employees.
- ➢ w_2: *price of materials* is the ratio between total cost of food and drink and the operating revenue.
- ➢ w_3: *price of other operating costs* is the ratio between other operating costs and operating revenue.
- ➢ w_4: *price of physical capital* is the ratio between the depreciation of fixed assets and the fixed assets.

The dependent variable of the cost frontier, total operating costs (C), is calculated as the sum of the costs of personnel, materials, other operating costs and depreciation of fixed assets. Furthermore, the dependent variable of the profit frontier (π) is defined as earnings before interest and taxes (EBIT).

Regarding the function of cost and profit inefficiency, the variables specified are as follows:

- ➢ Z_1: *4-star* is a category dummy variable that takes the value 1 if the hotel has 4 stars and 0 if the hotel has 3 or 5 stars.
- ➢ Z_2: *5-star* is a category dummy variable that takes the value 1 if the hotel has 5 stars and 0 if the hotel has 3 or 4 stars.
- ➢ Z_3: *Time trend* takes the value 1 in 2009, 2 in 2010, 3 in 2011, 4 in 2012 and 5 in 2013.

Table 1 lists the descriptive statistics of the output variables, input prices, total cost, profits and explanatory factors of inefficiency. To correct for variations due to the effect of prices, all the monetary variables have been deflated by the price index in the sector, calculated as 2007 $=$ 100 (INE, 2015).

6. Empirical results

The software used to estimate stochastic cost frontier (equation (3)), function of cost inefficiency effects (equation (4)), stochastic profit frontier (equation (7)) and the function of the profit inefficiency effects (equation (8)) was the FRONTIER 4.1 program developed by Coelli (1996). The results of the maximum likelihood estimation of the parameters of the cost function and the inefficiency effects function are presented in Table 2.

Table 1
Descriptive statistics (2009–2013).

	Average	Minimum	Maximum	SD
DEPENDENT VARIABLES				
Operating costs[a]	4533.86	101.03	81,168.08	7157.23
EBIT[a]	222.19	−18,043.82	38,846.00	1675.39
OUTPUTS				
Operating revenue[a]	4579.79	4.07	72,894.08	7267.44
Other operating revenue[a]	133.07	0.00	12,508.99	531.13
INPUT PRICES				
Price o labour[a]	27.92	9.96	46.57	5.48
Price of materials	0.1877	0.0016	0.6306	0.0899
Price of other operating costs	0.3139	0.0313	1.6093	0.1390
Price of capital	0.0672	0.0009	0.2948	0.0488
INEFFICIENCY DETERMINANTS				
4* category	0.51	0	1	0.50
5* category	0.08	0	1	0.27

[a] In thousands of euros.

Table 2
Maximum likelihood estimates (cost frontier).

Variables	Parameters	Coefficients	t-ratio
Cost function			
Constant	α_0	3.1467	8.5338*
ln y_1	α_1	0.2480	6.0449*
ln y_2	α_2	0.2625	12.1136*
ln w_1/w_4	β_1	0.0379	0.2930
ln w_2/w_4	β_2	0.4483	8.2519*
ln w_3/w_4	β_3	0.6956	8.0641*
½ (ln y_1)^2	α_{11}	0.0807	22.4301*
ln y_1 ln y_2	α_{12}	−0.0275	−17.5488*
½ (ln y_2)^2	α_{22}	0.0208	15.2374*
½ (ln w_1/w_4)^2	β_{11}	0.0562	2.1321**
ln w_1/w_4 ln w_2/w_4	β_{12}	−0.0731	−7.3802*
ln w_1/w_4 ln w_3/w_4	β_{13}	−0.0481	−2.6103*
½ (ln w_2/w_4)^2	β_{22}	0.0906	17.3041*
ln w_2/w_4 ln w_3/w_4	β_{23}	−0.0085	−1.1915
½ (ln w_3/w_4)^2	β_{33}	0.1099	6.8301*
ln y_1 ln w_1/w_4	ρ_{11}	0.0223	2.8221*
ln y_1 ln w_2/w_4	ρ_{12}	0.0253	6.9959*
ln y_1 ln w_3/w_4	ρ_{13}	−0.0328	−5.6888*
ln y_2 ln w_1/w_4	ρ_{21}	−0.0168	−3.8200*
ln y_2 ln w_2/w_4	ρ_{22}	−0.0063	−3.1322*
ln y_2 ln w_3/w_4	ρ_{23}	0.0180	5.5223*
Function of inefficiency effects			
Constant	δ_0	−2.0021	−11.0319*
Category 4*	δ_1	1.3171	13.1221*
Category 5*	δ_2	1.5872	13.8928*
Time trend	δ_3	−0.1754	−15.5283*
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	σ^2	0.1360	15.3201*
$\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$	γ	0.9045	138.9319*
Log-likelihood function		2434.21	
LR test of the one-sided error (with number of restrictions = 5)		381.36	
Number observations = 4190			

Notes: The LR statistic is the log-likelihood ratio and it has a mixed chi-square distribution.
*Statistically significant at 1% ($p < 0.01$).
**Statistically significant at 5% ($p < 0.05$).

Table 3
Frequency distribution and mean cost fficiencies.[a]

Efficiency bands	Frequency distribution				
	2009	2010	2011	2012	2013
0%–59%	2	2	2	2	1
60%–79%	36	19	13	7	3
80%–89%	201	144	123	106	59
90%–99%	599	673	700	723	775
MEAN EFFICIENCY	91.22% (0.057)	92.45% (0.046)	92.96% (0.043)	93.45% (0.046)	94.24% (0.043)
MEAN EFFICIENCY 2009–2013			92.86 (0.048)		

[a] Note: standard deviation in parentheses.

The estimation of stochastic frontier parameters shows a good choice of output variables and input price variables as well as a good fit between the data and the translog functional form of the cost function specified in this paper. Proof of this is that 19 of the 21 parameters that make up the frontier are significant.

Parameter γ, which is the ratio between inefficiency variance and composite error variance, reflects the percentage of the deviation from the frontier that is explained by inefficiency. If $\gamma = 0$, there would be no inefficiency and if $\gamma = 1$, there would be no random error. As shown in Table 2, the value $\gamma = 0.9045$ is very close to 1 and is significantly different from 0, which confirms the importance of the component of inefficiency in explaining the deviation of hotels from their efficient frontier. Similarly, the likelihood-ratio test (LR test)[2] verifies that the specified model is correct. This test is based on the null hypothesis that all the parameters of the inefficiency effects function are zero (H_0: $\gamma = \delta_0 = \ldots = \delta_3 = 0$); in this case, the LR test is 3082.24, so the null hypothesis at the 1% significance level is rejected.

Table 3 shows the frequency distribution in relation to the cost efficiency results. Similarly, the mean efficiency for all the hotel establishments in the sample, in each of the years studied, is shown as well as the overall cost efficiency from 2009 to 2013. The overall mean cost efficiency is 92.86%, indicating that the hotels in the sample could save 7.14% of their average costs while maintaining the same level of services.

Regarding the estimation of the inefficiency effects function, the coefficient of the time trend variable is significantly different from zero and has a negative sign, indicating that cost inefficiencies vary over time with a decreasing tendency. The estimate of the inefficiency effects function also reveals that the coefficients of the *4-star* (hereinafter C4) *and the 5-star category* (hereinafter C5) variables are statistically significant at the 1% level and have a positive sign, indicating that the number of stars of the hotels is a determining factor of cost inefficiency. This result shows that hotels reduce their cost efficiency by moving from a 3- to a 4- or 5-star category as well by moving from 4 to 5 stars (the difference between the coefficients of C5 and C4 is positive). As expected, increasing the category of a hotel implies an improvement in quality and involves an extra cost, so that the hotels offering higher quality services are penalized in terms of cost efficiency compared with lower quality ones. Therefore, hypothesis 1 of the research, which states that there is a negative relationship between hotel category and cost efficiency, is accepted.

The result of the maximum likelihood estimation of the parameters of the profit function and the inefficiency effects function are presented in Table 4.

The estimation of the parameters of the stochastic profit frontier also exhibits a good choice of output variables and input price variables and a good fit between the data and translog functional form, as 19 out of the 22 parameters are statistically significant. In addition, the value of γ is 0.9934, which is very close to 1, so we can say that most of the distance between the hotels and their optimal profit frontier is due to inefficiency and a small part due to random errors. Similarly, the value of the LR test is 756.10, verifying that the specified model is correct; that is, the null hypothesis that the parameters of the explanatory variables of the inefficiency effects function are zero is rejected (H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = 0$).

Table 5 shows the frequency distribution in relation to the profit efficiency results, the mean efficiency per year for all the hotels in the sample and the overall profit efficiency from 2009 to 2013.

The overall average profit efficiency is 50.36%, which means that on average a hotel could increase its profit by 49.64% if operating at an efficient frontier. This means that the average maximum profit[3] is approximately 440 thousand euros. Therefore, on average, the hotels in the sample are losing profits of around 218,000 euros (the result of multiplying the maximum profit by the profit inefficiency). Clearly, the efficiency level of profits (50.36%) is much lower than that obtained in the case of cost efficiency (92.86%), revealing the existence of strong revenue inefficiencies.

[2] The LR test is equal to $\lambda = -2\{(\log(\text{Likelihood}(H_0)) - \log(\text{Likelihood}(H_1))\}$ and approximately follows a χ_n^2 distribution with n equal to the degrees of freedom. To perform the required tests for the hypotheses, the critical values are selected from Table 1 of Kodde and Palm (1986).

[3] Calculated as the ratio between the average current profit (222,000 euros, see Table 1) and the overall profit efficiency (50.36%, see Table 5).

Table 4
Maximum likelihood estimates (profit frontier).

Variables	Parameters	Coefficients	t-ratio
Profit Function			
Constant	$\alpha 0$	22.3053	9.9176*
ln y_1	$\alpha 1$	−1.7227	−6.1352*
ln y_2	$\alpha 2$	0.4707	3.0137*
ln w_1/w_4	$\beta 1$	−6.7388	−8.2559*
ln w_2/w_4	$\beta 2$	1.5014	4.2529*
ln w_3/w_4	$\beta 3$	6.5914	11.2899*
½ (ln $y_1)^2$	$\alpha 11$	0.0936	4.0118*
ln y_1 ln y_2	$\alpha 12$	−0.0566	−5.3719*
½ (ln $y_2)^2$	$\alpha 22$	0.0333	3.4049*
½ (ln $w_1/w_4)^2$	$\beta 11$	1.0306	5.8546*
ln w_1/w_4 ln w_2/w_4	$\beta 12$	−0.3311	−4.9832*
ln w_1/w_4 ln w_3/w_4	$\beta 13$	−0.8759	−6.7733*
½ (ln $w_2/w_4)^2$	$\beta 22$	0.0896	2.3573**
ln w_2/w_4 ln w_3/w_4	$\beta 23$	0.3245	6.6950*
½ (ln $w_3/w_4)^2$	$\beta 33$	0.6708	5.9028*
ln y_1 ln w_1/w_4	$\rho 11$	0.4201	7.9046*
ln y_1 ln w_2/w_4	$\rho 12$	−0.0016	−0.0662
ln y_1 ln w_3/w_4	$\rho 13$	−0.3286	−8.4224*
ln y_2 ln w_1/w_4	$\rho 21$	−0.0078	−0.2536
ln y_2 ln w_2/w_4	$\rho 22$	−0.0297	−2.1149**
ln y_2 ln w_3/w_4	$\rho 23$	0.0171	0.7378
Ln NPI	θ	−0.9494	−225.2595*
Function of inefficiency effects			
Constant	δ_0	−59.6384	−5.2529*
4* category	δ_1	−4.5330	−5.4603*
5* category	δ_2	−2.0419	−4.1278*
Time trend	δ_3	−0.3166	−3.8046*
$\sigma^2 = \sigma_v^2 + \sigma_u^2\sigma^2$	σ^2	64.5166	5.4630*
$\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$	γ	0.9934	828.0958*
Log-likelihood function		−6318.32	
LR test of the one-sided error (with number of restrictions = 5)		756.10	
Number observations = 4190			

*Statistically significant at 1% ($p < 0.01$).
**Statistically significant at 5% ($p < 0.05$).

Table 5
Frequency distribution and mean profit efficiencies.[a]

Efficiency bands	Frequency distributions				
	2009	2010	2011	2012	2013
0%–19%	110	113	100	114	113
20%–29%	61	61	62	52	66
30%–39%	68	81	80	65	72
40%–49%	96	109	97	90	72
50%–59%	146	158	142	137	150
60%–69%	191	164	210	214	193
70%–79%	158	137	137	146	154
80%–99%	8	15	10	20	18
MEAN EFFICIENCY	50.45% (0.22)	49.21% (0.21)	50.46% (0.21)	51.01% (0.22)	50.65% (0.21)
MEAN EFFICIENCY2009–2013			50.36% (0.22)		

[a] Note: standard deviation in parentheses.

Regarding the estimation of the inefficiency effects function, again the coefficient of the time trend variable is significantly different from zero and negative in sign, indicating that profit inefficiency also varies over time with a decreasing trend. Similarly, the coefficients of variables C4 and C5 are significantly different from zero and negative in sign, indicating that the number of stars of a hotel is also a determining factor of profit inefficiency. However, unlike cost efficiency, the negative sign of the coefficient of C4 indicates that the partial effect on profit efficiency of a hotel increasing its category from three to four stars is positive; that is, four-star hotels are more profit efficient than three-star ones.

In addition, the negative sign of the coefficient of the C5 variable reveals that the partial effect on the level of profit efficiency of increasing the hotel category from three to five stars is positive; therefore, five-star hotels are more profit efficient than three-star hotels. This result shows that the extra cost of higher quality hotels, four- and five-star ones compared with three-star ones, is more than offset by their higher revenues.

By contrast, the difference between the coefficients of variables C4 and C5 is positive, meaning that a decrease in profit efficiency would result from a hotel in the sample increasing its category from four to five stars. This indicates that the increase in revenues accounting for a hotel improving its quality by moving from four to five stars would not be worth the extra cost.

The Pearson correlation between cost efficiency and profit efficiency is −0.118 (bilateral significance 0.001), which confirms the above results, i.e., the hotels that are the most cost efficient have the lowest profit efficiency and vice versa. As noted above, this may be because many of the cost inefficiencies that are normally estimated are, in fact, unmeasured differences in output quality that require extra costs to be created. This negative correlation could also be explained by competitive pressure: higher quality companies feel less market discipline to control their costs (Berger & Mester, 1997). Consequently, these results allow us to accept partially hypothesis 2, which states that there is a positive relationship between the hotel category and profit efficiency.

7. Conclusions and implications

The review of the economic literature on efficiency in the hotel industry show that most studies have focused their analysis on cost efficiencies and few concentrate on the analysis of revenue efficiencies. From our point of view, the concept of cost efficiency has significant limitations, because it does not identify any differences in the quality of services provided by hotels, which can lead to erroneous estimates of efficiency. Quality has become a key mechanism for success and survival in highly competitive sectors such as the hotel sector, forming loyalty among customers, attracting new ones and improving reputation and revenue (Berry et al., 1989; Chen, 2013; Saleem & Raja, 2014).

If the differences in service quality are not taken into account, higher quality hotels could mistakenly be considered to be more inefficient, when in fact there are unmeasured differences in quality. In this sense, a correct measure of efficiency should take into account both the quantity and quality of outputs (Assaf & Magnini, 2012). The concept that best reflects the effects of quality on both costs and revenue and their interaction is profit efficiency.

Given the existence of certain gaps in the literature on hotel efficiency regarding differences in service quality, this paper analyses the impact of quality on efficiency. It estimates the cost and profit efficiencies of 838 hotels in Spain in the period 2009–2013 using a stochastic frontier methodology and the model proposed by Battese and Coelli (1995).

The results show that hotels are operating with high cost efficiency (92.86%) and relatively low profit efficiency (50.36%), showing significant revenue inefficiencies. Moreover, the results confirm that the higher quality of hotels with four and five stars, relative to three-star ones, has a positive impact on the overall efficiency, as the extra cost of the highest quality is more than offset by the higher revenue. However, the higher quality category of five-star hotels compared with four-star ones has a negative impact on the overall efficiency; that is, the extra cost of the highest quality is not offset by higher revenues.

In conclusion, we can say that quality affects both costs and revenue, so if only cost efficiency is estimated, this will give a partial view of the impact of quality, as unmeasured differences in the quality of services are considered to be inefficient. To estimate the overall effect of quality (on costs and revenues), profit efficiency must be estimated, as it detects differences in the service quality provided by hotels. Therefore, it can be concluded that quality has a significant impact on the measure of the overall efficiency of a hotel company and the concept of profit efficiency is much more appropriate than that of cost efficiency to measure efficiency.

This is a very powerful conclusion for hotel management, since, in a scenario of establishments with different categories and qualities, management decisions should be based on information on profit efficiency and not so much on the erroneous information supplied by cost efficiency. Consequently, the results have important implications for hotel management in the sense that strategies should be implemented to increase the value of the services rendered and/or services with higher margins as a way to achieve sustainable competitive advantages in the market. In this sense, hotels of the highest category should (1) improve their employee qualifications, as this has a great impact on quality, (2) expand the range of services that have higher margins, (3) improve customer service, and (4) enhance brand loyalty and image through promotional and communication strategies. All this would lead to greater customer loyalty and quality, which translates into an increase in sales and the levels of occupation and, consequently, a reduction in revenue inefficiency.

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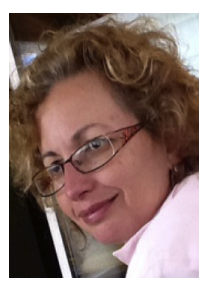

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