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Performance evaluation of the hotel industry in an emerging tourism destination: The case of Oman

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A B S T R A C T

This study is concerned with evaluating the performance of the hotel industry in the Sultanate of Oman through a two-stage data envelopment analysis (DEA) procedure. In the first stage, DEA-bootstrap is used to estimate point and interval efficiency ratios of the hotels, identify the benchmark hotels and suggest a potential ranking. In the second stage, a truncated regression model based on the double bootstrapping procedure of Simar & Wilson (2007) is implemented to identify potential sources of hotels' operational inefficiency. In addition, an empirical approach is introduced to quantify the attractiveness of tourism destinations through a weighting scheme.

The benchmarking analysis is carried out on a sample of 58 hotels, and revealed that (1) the majority of hotels in Oman are technically inefficient; (2) most of the efficient hotels are located in the capital, Muscat; (3) star rating and cultural attractions are the most important factors influencing hotels' efficiency. Practical implications of these findings are also discussed.

1. Introduction

The sultanate of Oman is located on the southern tip of the Arabian Peninsula with, on its borders, the United Arab Emirates (U.A.E.), Saudi Arabia (S.A.), and Yemen. Oman covers an area of 309,500 km^2, with rugged mountains and rocky deep-water fjords to the north, the mountains and green hills of the Dhofar region to the south, and the Wahiba Sands in the center (Choufany & Younes, 2005). Lying on the Tropic of Cancer, Oman is one of the world's hot and arid regions, though part of the south of the country has a tropical climate (Fig. 1).

Oman's economy is oil based, with an oil activity accounting for 30% of Gross Domestic Product (GDP) and representing 61% of total exports, estimated to $53bn in 2012 (QNB, 2013). Oman has been successful at turning its oil wealth into broad-based economic growth, stirred by the government's strategy of diversifying the economy and reducing dependence on petroleum resources. Although the latest among the Gulf countries to join the tourism "race", Oman is emerging as one of the most attractive tourism destinations on the Arabian Peninsula with the number of tourists increasing every year (Winckler, 2007). Moreover, tourism industry is perceived among the key alternatives to petroleum based economy (Subramoniam, Al-Essai, Al-Marshadi, & Al-Kindi, 2010) and set as one of the top targets of the long-term socio-economic plan, namely, "Oman 2020" (Winckler, 2007). The industry's total contribution to GDP nears 5.7% in 2015, with 111,500 jobs, equivalent to 5.7% of total employment (WTTC, 2016). The forecast for 2023 is 117,000 jobs supported by the industry (WEF, 2013).

With a sector expanding so rapidly, measures are being taken by the Omani government to boost tourism competitiveness, expand tourist base, facilitate travel activities, and endorse innovative initiatives (Assaf & Barros, 2011). As the largest and arguably the most important actors of tourism industry, hotels must compete globally to attract customers and achieve high profits (Tarim, Dener, & Tarim, 2000). Viewed from this perspective, conducting a performance evaluation of the hotel industry is a necessary step to developing a meaningful set of benchmarks for best practices and successful hotel businesses (Min, Min, & Joo, 2009). Such a focused study can help stakeholders to determine current competitive positions of different hotels in the Omani market, in addition to supporting decisions pertaining to the improvement of operational performance, downscaling specific operations, or deferring scheduled expansions (Assaf & Barros, 2011). To the authors' best knowledge, apart from the work of Oukil and Al-Zaidi (2014), performance of the hotel industry has never been researched in

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Fig. 1. Map of Oman.

Oman's context specifically. Therefore, the present paper adds to previous research in this field.

This study uses a two-stage approach (Barros, Botti, Peypoch, & Solonandrasana, 2011; Shang, Wang, & Hung, 2010). The approach starts with a Data Envelopment Analysis (DEA) evaluation of the hotels' technical efficiencies, followed by a statistical regression of the efficiency scores over a set of contextual factors. The objective of the second stage is to identify the factors that contribute more significantly to the efficiency of the hotels. A truncated regression model with a double bootstrapping procedure (Simar & Wilson, 2007) is implemented to identify these factors, but also to assess the consistency of the DEA efficiency scores.

In the light of the above, the contribution of the present study to the hospitality and tourism literature is two-fold. First, the study investigates efficiency measures of the Omani hotel industry, a topic that has not been addressed hitherto, in spite of its pertinence to such a growing industry. Second, the study examines the contextual factors that impact the hotel industry in Oman, with possible extension to other tourism destinations with similar characteristics. Concurrently, an empirical approach is introduced to quantify the attractiveness features of touristic destinations.

The remainder of the paper unfolds as follows. In the next section, a brief review of the literature pertaining to the two-stage approach in the hotel industry is presented. Section 3 outlines the methodology of the study. Section 4 is dedicated to the discussion of the results related to point and interval estimation of the hotels' efficiency scores. In Section 5, the potential relation between the hotel contextual factors and efficiency levels is discussed. The paper concludes with some recommendations and possible venues for future research.

2. Literature review

In recent years, the measurement of efficiency in the hotel industry has mostly been addressed through frontier efficiency methods, namely, the stochastic frontier (Greene, 2008) and data envelopment analysis (Cooper, Seiford, & Tone, 2002). The stochastic frontier analysis (SFA) requires the output of the decision making units (DMUs) to be expressed as an explicit function of a set of inputs, an inefficiency factor, and a random error whose distribution is assumed a priori (Coelli, Rao, O'Donnell, & Battese, 2005). Some leading studies that use SFA in the hotel industry include Anderson, Fish, Xia, & Michello (1999), Barros (2004, 2006), Chen (2007), and Hu, Chiu, Shieh, and Huang (2010). Unlike SFA, data envelopment analysis (DEA) is a non-parametric approach that does not impose functional forms on the data nor does it need to use probability distributions (Barros et al., 2011). Furthermore, DEA has the potential to evaluate the efficiency of DMUs that employ multiple inputs (resources) to produce multiple outputs (products and/or services).

According to Wöber (2007) "*Although efficient frontier methods have been used extensively in the past, it has been just recently that tourism researchers have discovered DEA for examining efficiency in their industry*". Indeed, the share of tourism is estimated to only 1.34% of all DEA application papers (Liu, Lu, Lu, & Lin, 2013). Hruschka (1986) and Banker and Morey (1986a) are first to apply DEA to the hospitality industry, more specifically, to restaurants. Later, Bell & Morey (1994, 1995) use DEA to determine best practices for corporate travel agencies. The application of DEA to the hotel industry is pioneered by Morey and Dittman (1995).

Over 63% of related publications cover destinations in the Asian Pacific region (Assaf, 2012; Keh, Chu, & Xu, 2006), with around 50% dealing with the hotel industry only in Taiwan (e.g., Assaf, Barros, & Josiassen, 2010; Chin, Wu, & Hsieh, 2013; Huang, Ho, & Chiu, 2014). Research on the performance of hotels in the Middle East using DEA is very scarce. The few existing publications consider cases in Turkey (e.g., Tarim et al., 2000; Tumer, 2010; Önüt & Soner, 2006), Iran (Shirouyehzad, Hosseinzadeh Lotfi, Shahin, Aryanezhad, & Dabestani, 2012) and Israël (Hadad, Friedman, & Israeli, 2005). Apart from the study in Assaf and Barros (2011) which involves hotel chains from S.A., the U.A.E. and Oman, there is no known research dedicated specifically to performance analysis of the hotel industry in Oman. Therefore, the present work enriches the literature in this field through a systematic analysis of hotels' performance in Oman with a view to identify benchmarks for best practices and support stakeholders' operational decisions.

Our methodological approach covers two-stages. The first stage uses DEA to estimate the hotels' efficiency scores. In the second stage, an econometric analysis is conducted to discern possible correlation between the DEA efficiency scores and the contextual factors. The latter are often exogenous factors that are neither inputs nor outputs, but can still influence the operating process (Jeong, Park, & Simar, 2010). The objective is to identify the factors that might influence efficiency significantly.

The application of the two-stage approach in the hotel industry is quite recent. Early studies have investigated the effect of hotel contextual factors on efficiency using ordinary least squares (OLS) estimation (e.g., Sun & Lu, 2005). However, the OLS estimation has been considered unsuitable for explaining the efficiency scores since the latter variables are bounded. Instead, Tobit regression models have been used in subsequent research. In Hu, Shieh, Huang, and Chiu (2009), DEA is adopted to evaluate the operational performance of international tourist hotels (ITHs) in Taiwan through cost, allocative, technical, and scale efficiency ratios. In the second stage, each of these ratios is regressed on a set of environmental variables using Tobit model (Tobin, 1958). A similar approach is also used in Chen, Hu, and Liao (2010), Honma and Hu (2012) and Huang, Mesak, Hsu, and Qu (2012). Simar and Wilson (2007) argue that the efficiency estimates are serially correlated, which renders the standard inference approaches used in the conventional two-stage DEA procedure statistically invalid. Therefore, the truncated regression model is used to deal with the bias problems in the second stage of the DEA approach. Under the assumption that the distribution of efficiency is truncated normally with a mean of zero, Barros and Dieke (2008) examine the determinants of efficiency of African hotels. More recently, the truncated regression is applied with a bootstrapping procedure in Barros et al. (2011), Chen et al. (2010), Tundis, Corsino, and Zaninotto (2012), Fang (2013), Hu, Yeh, and Tsai (2014) and Hathroubi, Peypoch, and Robinot (2014). More extensive reviews and references can be found in, e.g., Manasakis, Apostolakis, and Datseris (2013) and Fang (2013).

In this paper, a truncated regression model with a double bootstrapping procedure (Simar & Wilson, 2007) is used (1) to estimate the bias and produce confidence intervals for the efficiency scores of the hotels in Oman, and (2) to discriminate the contextual factors that have substantial effect on these scores.

3. Methodological framework

The DEA models that are most frequently applied in the hotel industry are CCR (Charnes, Cooper, & Rhodes, 1978), which assumes constant returns to scale (CRS), and BCC (Banker, Charnes, & Cooper, 1984), which allows variable returns to scale (VRS). VRS implies disproportionate variation in outputs when inputs are increased. Under either CRS or VRS assumption, the managerial purposes of efficiency analysis, in a competitive context, are the measurement of relative efficiency ratios as an essential step to setting industry's benchmarks besides achieving more profit. Therefore, the output-oriented versions of CCR and BCC models are more suitable. Other models are used in the literature, depending on the contexts and managerial objectives.

3.1. Efficiency estimation

Assume a set of K hotels, each hotel k defined with N inputs x and M outputs y. With reference to the underlying production technology, hotel (x_k, y_k) is fully defined with the observed values x_{ik} and y_{jk}, with $i = 1,\ldots, N$ and $j = 1,\ldots, M$. To estimate the efficiency score θ_h of hotel (x_h, y_h) and set production targets for inefficient hotels, the output-oriented formulation of CCR model can be represented as follows.

$$\max \theta_h \tag{1}$$

Subject to:

$$(\text{CCR}) \quad \sum_{k=1}^{K} \lambda_k x_{ik} \leq x_{ih} \quad i = 1, \ldots, N \tag{2}$$

$$\sum_{k=1}^{K} \lambda_k y_{jk} \geq \theta_h y_{jh} \quad j = 1, \ldots, M \tag{3}$$

$$\lambda_k \geq 0 \quad k = 1, \ldots, K \tag{4}$$

The efficiency θ_h of hotel (x_h, y_h) represents the maximal radial increase of outputs that is required to reach the efficiency frontier for a specified level of inputs. The vector λ measures the weights of peers in producing the projection of hotel (x_h, y_h) on the efficiency frontier. Constraints (2) and (3) state that reference points are linear combinations of the input and output values of efficient peers for hotel (x_h, y_h).

BCC model can be obtained from (CCR) by adding the convexity constraint that guarantees that only weighted averages of efficient hotels enter the reference set, i.e. $\sum_{k=1}^{K} \lambda_k = 1$.

The adequate choice of *inputs* and *outputs* for a DEA based benchmarking problem lies often on the dicta *"less is better"* and *"more is better"*, respectively (Cook, Tone, & Zhu, 2014). Thus, with respect to the specific context of our study, we identified 4 outputs and 4 inputs.

The output variables are *Annual revenue* (Barros & Mascarenhas, 2005; Chiang, Tsai, & Wang, 2004; Neves & Lourenco, 2009; Pulina, Detotto, & Paba, 2010), *Number of guests* (Barros, 2005b), *Number of nights* (Barros & Mascarenhas, 2005; Barros, 2005b; Sigala, Jones, Lockwood, & Airey, 2005) and *Occupancy rate* (Chiu, Huang, & Ting, 2012; Ting & Huang, 2012; Yang & Lu, 2006). *Annual revenue* includes incomes from the rental of the hotel rooms, food and beverages served to customers, phone call bills, as well as laundry services. *Number of guests* counts hotel's guests, regardless of the duration of their stay. *Number of nights* provides a cumulative value of full nights spent in the hotel. *Occupancy rate* refers to the proportion of hotel capacity effectively used over a specific time period (e.g. one year), i.e. number of rooms rented out over the total number of rooms available. Occupancy rate has been used recently and it is managerially useful (Perrigot, Cliquet, & Piot-Lepetit, 2009). The input variables are *Number of beds* (Manasakis et al., 2013), *Number of rooms* (Anderson, Fok, & Scott, 2000; Assaf et al., 2010; Barros, 2005b; Chen et al., 2010), *Number of employees* (Barros & Mascarenhas, 2005; Chiang et al., 2004; Hwang & Chang, 2003), and *Salary of employees* (Assaf & Agbola, 2011; Morey & Dittman, 1995; Reynolds, 2003).

The data used for this study have been collected from the Ministry of Tourism through direct access to the database of hotels available at the department of Statistics & Geographic Information. All required information was obtained for 58 hotels, spread over seven regions of Oman (Muscat, Dhofar, Al-Buraymi, A'Dakhiliyah, A'Sharqiyah, Al-Batinah, and Musandam). A statistical summary of the corresponding inputs and outputs is given in Table 1.

Note that *Number of rooms* and *Number of beds* are strongly correlated, with a correlation coefficient $r_{br} = 0.9768$. The same holds for the input variables *Number of employees* and *Salary of employees*, with $r_{es} = 0.9087$. Therefore, *Number of beds* and *Salary of employees* are the only input variables we consider for the analysis.

3.2. Identification of efficiency drivers

Commonly, the efficiency estimation is carried out without considering contextual factors that may influence the outcome of the hospitality operations. The second stage analysis is conducted to assess the cross-sectional association of these factors with the DEA efficiency scores. In an output orientated DEA model, these scores' estimators are biased upward for this data configuration and bounded on the left at 1 ($1 \leq \theta_h$) that is, $\theta_h - 1$ is the proportional increase in outputs that could be achieved by hotel h with input quantities held constant. If z_h denotes the vector of contextual variables and β the associated coefficients in a regression model, we have $\theta_h = \beta\, z_h + \varepsilon \geq 1 \Rightarrow \varepsilon \geq 1 - \beta\, z_h$, where ε is the error term, $\varepsilon \sim N(0, \sigma_\varepsilon)$.

Therefore, a truncated regression of the inefficiency scores $\theta_h - 1$ against the contextual variables z_h can be used to identify the factors that may influence more significantly the efficiency estimates.

In the hotel industry, examples of contextual factors include

Table 1
Summary statistics of Input and Output variables.

Variables	Unit	Mean	SD	Min.	Max.
Output					
Annual revenue	$/year	6,911,989	13,731,079	3004	78,795,452
Number of guests		17,864	20,273	597	96,877
Number of nights		23,882	28,091	669	147,084
Occupancy rate	%	55	24	2	87
Inputs					
Number of beds		135	138	23	937
Salary of employees	$/year	1,040,976	2,197,535	14,344	11,704,068

Table 2
Quantification of attraction categories.

Region	Nature	Culture	Activities
Muscat	16	16	13
Dhofar	19	8	13
Al Buraymi	5	5	13
A'Dakhiliyah	11	12	12
A'Sharqiyah	2	6	3
Al Batinah	1	3	0
Musandam	4	1	9

hotel size (Assaf et al., 2010), location (Barros, 2005a; Bernini & Guizzardi, 2010; Tundis et al., 2012), and type of ownership (Barros & Dieke, 2008), which are found to be strong determinants of hotel efficiency in many case studies. Other variables could also be pertinent, like star rating (Assaf & Cvelbar, 2010), used essentially to reflect quality of service, even though it is far from being a wholly satisfactory proxy for such an operational factor (Oliveira, Pedro, & Marques, 2013).

Based on previous studies, we consider four contextual variables: *Type of ownership*, *Hotel size*, *Star rating* and *Attractions.* The variable *Attractions* is introduced to investigate the influence of hotel's location on its efficiency. Bernini and Guizzardi (2010) suggest that location is positively correlated with technical efficiency, especially for sun and beach destinations, as well as cities with renowned cultural importance. Thus, resources that may contribute to the attractiveness of a hotel's location need to be conserved (Gomezelj & Mihalič, 2008). The latter being nominal, it cannot be used in a regression model without a prior quantification. For that reason, the number of attractions is used as a quantitative substitute.

Based on the classification of the Ministry of tourism, there are three categories of attractions: *Nature*, *Culture*, and *Activities.* The items that fall under each category are as follows:

- **Nature:** Reserves, valleys, strait of Hormuz, mountains, caves, deserts, beaches, islands, water springs, lagoons, rocks park, canyon, Muscat geo-site.
- **Culture:** Aflaj system, traditional villages, souqs, world heritage, museums, forts, castles, archaeological and religious sites, crafts, frankincense, cities.
- **Activities:** Scuba diving, boating, climbing, Via Ferrata, trekking, camping, caving, golf, kite-surfing, kite-boarding, shopping, watching (whales, birds, turtles, dolphins), racing (camels, horses), off-road, Muscat geo-heritage.

In order to gauge the individual effect of each category and draw more focused decisions, we consider them as separate variables.

Accordingly, the variable location is represented with three variables, whose values are calculated as follows. First, we identify all potential attraction sites and activities related to each destination. Next, we cluster these items based on the above classification scheme. Finally, we count the number of items for each category. Each number translates the weight of each location with respect to each attraction category. The values obtained are presented in Table 2.

For instance, the value of variable *Nature* is 16 for Muscat, that is, there are potentially 16 touristic sites in Muscat corresponding to, at least, one of the items listed under category *Nature*. Similar reasoning applies to the other variables. Muscat is, apparently, the most attractive with respect to cultural sites, while Dhofar is leading with its natural sites. The majority of regions offer some sort of activities, except Al-Batinah.

Regarding the other contextual variables, *Type of ownership* is a dichotomous variable taking a value 1 if the hotel is part of a chain of hotels, a value 0 otherwise. For *hotel size*, we use values 0, 1 or 2 depending on whether the hotel is *small*, *medium* or *large*, respectively, that is, the number of rooms is less than 100, between 100 and 300, or more than 300. *Star rating* refers to the number of stars assigned to a hotel for the previous year's exercise, a number varying between 1 and 5. Ray and Phillips (2005) and Assaf and Agbola (2011) suggest that the number of stars and efficiency are positively correlated, that is, the more stars, the better the performance.

The summary statistics for the contextual variables are given in Table 3.

3.3. Double bootstrapping procedure

According to Simar and Wilson (2007), conventional inference methods used in the two-stage DEA procedure are based on efficiency estimates that are serially correlated. As a result, related statistical inference might not be reliable. To enable consistent inference on the efficiency scores, Simar and Wilson (2007)

Table 3
Summary statistics of hotel contextual factors.

Variables	Unit	Mean	SD	Min.	Max.
Type of ownership	categorical	0.33	0.47	0	1
Hotel size	categorical	1.33	0.51	1	3
Star rating	categorical	2.81	1.41	1	5
Attractions:					
• Nature		12.36	6.37	1.00	19.00
• Culture		11.55	5.33	1.00	16.00
• Activities		10.53	4.81	0.00	13.00

develop a double bootstrap algorithm.

The bootstrapping concept is based on the idea that simulating the sampling distribution of interest is possible by mimicking the data-generating process (DGP). Under the assumption that the original data sample is generated by the DGP, the DEA efficiency scores are re-estimated with the 'simulated' data. Through multiple replications of this process, a Monte Carlo approximation of the sampling distribution is derived from the empirical distribution of the bootstrap values.

The double-bootstrapping procedure (Simar & Wilson, 2007) works as follows.

Step 1: Compute the efficiency score θ_h for each hotel (x_h, y_h) by solving model (CCR).

Step 2: Use truncated maximum likelihood estimation to regress θ_h against a set of contextual variables z_h and provide an estimate $\widehat{\beta}$ of the coefficient vector β and an estimate $\widehat{\sigma}_\varepsilon$ of σ_ε, the standard-deviation of the residual errors ε.

Step 3: Repeat the next sub-steps B_1 times for each hotel h ($h = 1, \ldots, K$) to produce a set of B_1 bootstrap estimates $\widehat{\theta}_{hb}$ for $b = 1, \ldots, B_1$.

3.1. Generate the residual error ε_h from the normal distribution $N(0,\widehat{\sigma}_\varepsilon^2)$ with left-truncation at $(1 - \widehat{\beta} z_h)$.

3.2. Calculate $\theta_h^* = \widehat{\beta} z_h + \varepsilon_h$.

3.3. Construct a pseudo data set (x_h^*, y_h^*) where $x_h^* = x_h$ and $y_h^* = y_h \theta_h / \theta_h^*$.

3.4. Run model (CCR) with the pseudo data set (x_h^*, y_h^*) to compute an estimate $\widehat{\theta}_h^*$ of the "real" efficiency score.

Step 4: Calculate the bias-corrected estimator $\widehat{\widehat{\theta}}_h$ for each hotel h ($h = 1, \ldots, K$) using the bootstrap estimator of the bias $\widehat{b}_h$ (Simar & Wilson, 1998, 2007) where $\widehat{\widehat{\theta}}_h = \theta_h - \widehat{b}_h$ and $\widehat{b}_h = \left(\frac{1}{B_1} \sum_{b=1}^{B_1} \widehat{\theta}_{hb}^* \right) - \theta_h$.

Step 5: Use truncated maximum likelihood estimation to regress $\widehat{\widehat{\theta}}_h$ on the contextual variables z_h and provide an estimate $\widehat{\beta}^*$ for β and an estimate $\widehat{\sigma}^*$ for σ_ε.

Step 6: Repeat the next sub-steps B_2 times to yield a set of B_2 pairs of bootstrap estimates $(\widehat{\beta}_b^{**}, \widehat{\sigma}_b^{**})$ with $b = 1, \ldots, B_2$.

6.1. Generate ε_h from the normal distribution $N(0,\widehat{\sigma}^{*2})$ with left-truncation at $(1 - \widehat{\beta}^* z_h)$ for each hotel h ($h = 1, \ldots, K$).

6.2. Calculate $\widehat{\theta}_h^{**}$ for each hotel h ($h = 1, \ldots, K$) so that $\widehat{\theta}_h^{**} = \widehat{\beta}^* z_h + \varepsilon_h$.

6.3. Use truncated maximum likelihood estimation to regress $\widehat{\theta}_h^{**}$ on the contextual variables z_h and provide an estimate $\widehat{\beta}^{**}$ for β and an estimate $\widehat{\sigma}^{**}$ for σ_ε

Step 7: Construct the estimated $(1 - \alpha)$% confidence interval of the j-th element β_j of the vector β, that is, $[\text{Lower}_{\alpha,j}, \text{Upper}_{\alpha,j}] = [\widehat{\beta}_j^* + \widehat{a}_\alpha, \widehat{\beta}_j^* + -\widehat{b}_\alpha]$ with $\text{Prob}(-\widehat{b}_\alpha \le \widehat{\beta}_j^{**} - \widehat{\beta}_j^* \le -\widehat{a}_\alpha) \approx 1 - \alpha$

4. Point and interval efficiency evaluation

The efficiency evaluation is performed using a code implemented under R version 3.0.1. In both parts of the double bootstrapping procedure, the computations are conducted over 3000 bootstrap iterations, i.e., $B_1 = B_2 = 3000$. All the results required less than 1 h of computer time, running on a desktop PC (HP double processor × 3.40 GHz, 8 GB RAM).

Table 4 provides, for each hotel, the initial efficiency estimate $\boldsymbol{\theta_h}$ obtained from model (1)–(4), the bias-corrected efficiency value $\widehat{\widehat{\theta}}_h$, and the lower and the upper bounds of the efficiency score's confidence interval computed at 95% significance level. The efficient hotels are highlighted in bold font.

The values of $\boldsymbol{\theta_h}$ show that only 8 hotels out of 58 are technically efficient under CRS and almost thrice (22 hotels) under VRS. Over the seven regions involved in the study, almost all the efficient hotels are located in Muscat. Such a high concentration is primarily justified, knowing that Muscat is the capital and hosts most of the important touristic sites, besides more than half the number of hotels. For the inefficient hotels, the associated reference sets (potential benchmarks) are given in Table 5 for VRS assumption.

The average results indicate that there is a considerable potential for efficiency improvement in terms of output increase while keeping the level of input constant. Indeed, the figures in Table 6 show that the inefficient hotels are required to expand their outputs by less than 1.8%, on average, except for the occupancy rate which needs to be increased by more than 25%. Hence, more focus could be put on the outputs *Annual revenue*, *Number of guests*, and *Number of nights* since the corresponding distances to the efficiency frontier are smaller.

Meanwhile, the interval estimates of pure technical efficiency scores, constructed with bootstrapping, reveal that, at 95% confidence, the average interval width is 0.393 for an average variance of 0.022. These intervals are relatively wider for the efficient hotels, with an average width of 0.414 and an average variance of 0.018, a minimum width of 0.098 and a maximum of 0.878. In the case of hotel performance research, this is an important finding if the purpose of the frontier estimation is to identify best and worst performing hotels. The narrower the widths of the confidence intervals the better one's position to statistically identify specific clusters of hotels in terms of relative efficiency.

For instance, the benchmark hotels under VRS technology can be ranked based on the widths of the associated confidence intervals, as in Table 7, where H18 (Safeer Continental Hotel) and H57 (Al-Shumukh Guest House) can be presented as, respectively, the first and the last ranked hotels in the group of the best performing hotels.

5. Identifying performance drivers

The results of the truncated regression analysis with the double bootstrap are displayed in Table 8 for both CRS and VRS technologies. The statistical significance of our results is assessed using 95% confidence intervals.

Since inefficiency is the regressand of the truncated model, parameters $\widehat{\beta}^{**}$ whose values are negative denote a potential for improvement and, as a result, the corresponding factors are source of efficiency.

With respect to individual significance levels, the results show that variables *Type of ownership*, *Hotel size*, *Nature* and *Activities* are statistically insignificant. With the exception of *Activities*, the coefficients of the latter variables are positive, suggesting a negative impact on hotel efficiency. In the meantime, the *Activities* variable affects positively technical efficiency in both CRS and VRs specifications albeit statistically insignificant.

Although the negative effect of the variable *Nature* is found to be statistically significant only under CRS assumption, such a result is unexpected as it conflicts with the trend of domestic tourism, known for being strongly influenced by natural factors. Yet, this result can be justified as the sample of hotels considered for our study includes very few hotels from nature-based touristic destinations, like Salalah.

On the other hand, the negative impact of hotel ownership on efficiency does not conform to the findings of related studies (e.g., Barros & Dieke, 2008). In practice, chain ownership is expected to boost efficiency through better management abilities, more

Table 4
Point and Interval efficiency scores using DEA bootstrap.

Hotel	*CRS*				*VRS*			
	θ_h	$\widehat{\theta}_h$	Lower bound	Upper bound	θ_h	$\widehat{\theta}_h$	Lower bound	Upper bound
H1	1.465	1.731	1.502	2.032	1.225	1.343	1.232	1.578
H2	1.844	2.343	1.892	2.819	1.098	1.189	1.103	1.363
H3	**1.000**	**1.210**	**1.034**	**1.370**	**1.000**	**1.181**	**1.006**	**1.473**
H4	**1.000**	**1.305**	**1.030**	**1.552**	**1.000**	**1.185**	**1.006**	**1.515**
H5	1.809	2.203	1.862	2.581	**1.000**	**1.182**	**1.007**	**1.506**
H6	1.396	1.630	1.431	1.823	1.099	1.181	1.105	1.336
H7	1.362	1.603	1.398	1.809	**1.000**	**1.119**	**1.006**	**1.247**
H8	1.049	1.233	1.077	1.377	**1.000**	**1.156**	**1.006**	**1.355**
H9	1.376	1.590	1.422	1.773	**1.000**	**1.105**	**1.006**	**1.224**
H10	2.059	2.356	2.114	2.635	1.434	1.531	1.444	1.623
H11	1.218	1.402	1.249	1.555	**1.000**	**1.114**	**1.006**	**1.243**
H12	1.656	1.874	1.697	2.087	1.060	1.133	1.067	1.226
H13	2.548	2.903	2.632	3.199	1.413	1.473	1.423	1.533
H14	**1.000**	**1.327**	**1.027**	**1.543**	**1.000**	**1.196**	**1.006**	**1.609**
H15	**1.000**	**1.194**	**1.025**	**1.322**	**1.000**	**1.130**	**1.006**	**1.266**
H16	**1.000**	**1.362**	**1.030**	**1.563**	**1.000**	**1.196**	**1.006**	**1.568**
H17	1.755	2.098	1.805	2.370	1.097	1.159	1.105	1.233
H18	2.359	2.796	2.434	3.145	**1.000**	**1.056**	**1.005**	**1.103**
H19	2.523	2.884	2.590	3.198	1.120	1.170	1.127	1.220
H20	2.079	2.440	2.129	2.807	1.618	1.764	1.627	1.950
H21	2.311	2.679	2.380	2.937	1.416	1.504	1.424	1.574
H22	2.655	3.194	2.740	3.674	1.252	1.306	1.260	1.374
H23	1.585	1.920	1.628	2.136	1.264	1.354	1.272	1.468
H24	2.127	2.588	2.179	2.929	**1.000**	**1.094**	**1.008**	**1.163**
H25	2.096	2.546	2.160	3.016	1.121	1.190	1.125	1.292
H26	1.016	1.168	1.042	1.312	**1.000**	**1.105**	**1.004**	**1.251**
H27	5.165	6.335	5.303	7.244	1.919	2.121	1.931	2.502
H28	**1.000**	**1.294**	**1.034**	**1.531**	**1.000**	**1.199**	**1.006**	**1.687**
H29	1.150	1.397	1.178	1.612	1.019	1.109	1.025	1.246
H30	1.111	1.327	1.128	1.542	**1.000**	**1.114**	**1.007**	**1.294**
H31	**1.000**	**1.229**	**1.029**	**1.452**	**1.000**	**1.188**	**1.006**	**1.583**
H32	1.004	1.136	1.022	1.267	**1.000**	**1.158**	**1.006**	**1.352**
H33	1.916	2.193	1.967	2.420	1.148	1.236	1.155	1.362
H34	4.602	5.483	4.732	6.131	1.637	1.725	1.647	1.804
H35	1.465	1.710	1.495	1.972	1.214	1.318	1.221	1.515
H36	9.459	11.088	9.613	12.742	8.542	9.224	8.610	10.051
H37	2.130	2.468	2.149	2.893	**1.000**	**1.206**	**1.006**	**1.882**
H38	2.253	2.668	2.317	3.035	1.203	1.330	1.210	1.619
H39	1.387	1.628	1.429	1.787	1.033	1.093	1.040	1.148
H40	**1.000**	**1.288**	**1.027**	**1.470**	**1.000**	**1.177**	**1.006**	**1.477**
H41	1.052	1.254	1.068	1.480	**1.000**	**1.179**	**1.007**	**1.439**
H42	1.931	2.209	1.976	2.461	1.142	1.238	1.148	1.384
H43	1.581	1.826	1.617	2.011	1.221	1.302	1.230	1.378
H44	2.000	2.387	2.040	2.786	1.545	1.683	1.555	1.953
H45	2.217	2.796	2.256	3.340	1.906	2.093	1.915	2.559
H46	9.351	11.264	9.499	13.278	8.940	9.815	8.992	11.555
H47	2.022	2.328	2.075	2.587	1.547	1.670	1.557	1.827
H48	3.357	4.073	3.460	4.703	2.165	2.359	2.176	2.621
H49	2.749	3.258	2.812	3.789	2.613	2.857	2.625	3.285
H50	3.062	3.660	3.131	4.031	1.747	1.841	1.757	1.963
H51	1.365	1.602	1.403	1.775	1.280	1.401	1.289	1.547
H52	1.217	1.416	1.253	1.567	**1.000**	**1.067**	**1.006**	**1.128**
H53	1.657	1.894	1.709	2.080	1.033	1.093	1.040	1.140
H54	1.649	1.864	1.661	2.192	1.632	1.762	1.640	1.985
H55	4.611	5.346	4.686	6.209	4.598	4.998	4.620	5.653
H56	1.185	1.398	1.204	1.638	1.024	1.134	1.029	1.386
H57	6.503	7.815	6.615	9.221	**1.000**	**1.205**	**1.006**	**1.884**
H58	1.294	1.457	1.335	1.615	1.151	1.232	1.158	1.333

accessibility to novel technologies, and higher capital at lower cost. On an aggregated level, only 32.76% of the hotels belong to a chain but account for 74.57% of the annual revenue, 56.03% of the number of guests, 62.79% of the number of nights, and 41.70% of the occupancy rate. Yet, these figures are not sufficient to assess the impact of hotel ownership on efficiency.

Regarding size, the hypothetical relationship is a positive relationship between hotel size and profit opportunity and, hence, hotel efficiency. However, the existing literature does not present converging results on the matter. While Barros and Dieke (2008) show that the larger the more efficient applies for African hotels, other researchers (e.g., Chen, 2007; Hwang & Chang, 2003) find that efficiency is not affected by size in the case of Taiwanese hotels, which also contradicts recent findings of Assaf et al. (2010). In our case, only 31.03% of the hotels fall under the category medium or large (more than 100 rooms) but represent all together 82.78%, 64.59%, 68.62% and 35.80% of the annual revenue, the number of guests, the number of nights and the occupancy rate, respectively. Again, these proportions being restricted to an aggregated cluster of hotels, they cannot be used to support decisions on an individual

Table 5
Reference sets of the inefficient hotels (VRS).

Hotel	Reference set
H1	H3-H4
H2	H4-H5-H8
H6	H3-H8-H15
H10	H9-H11-H16-H24-H28
H12	H8-H15-H32
H13	H4-H9-H15-H18
H17	H3-H24-H28-H31-H32
H19	H15-H18-H31-H52
H20	H16-H24-H28-H40
H21	H8-H9-H11-H24-H28-H32
H22	H15-H18-H31
H23	H3-H9-H16-H24-H28-H31
H25	H24-H28-H31
H27	H16-H28-H37-H57
H29	H24-H28-H40
H33	H8-H9-H15
H34	H15-H18-H24
H35	H26-H30-H40
H36	H25-H28-H30
H38	H16-H37-H41
H39	H15-H24-H28-H31
H42	H3-H24-H32-H40
H43	H9-H16-H24-H28-H32-H40
H44	H16-H28-H40
H45	H24-H28-H40
H46	H28-H37-H41
H47	H3-H16-H24-H32-H40
H48	H3-H16-H24-H40
H49	H16-H28-H40
H50	H8-H9-H15
H51	H3-H8-H15-H32
H53	H4-H9-H15-H18-H24
H54	H28-H41
H55	H-H28-H30
H56	H28-H37-H41
H58	H3-H15-H24-H31-H32

hotel level.

The variables *Star rating* and *Culture* are statistically significant and, consequently, are proven to be important sources of efficiency for hotels. The factor *Star rating* has more effect on efficiency than *Culture* as revealed from the corresponding parameters $\widehat{\beta}^{**}$. Indeed, the contributions $(\widehat{\beta}_3^{**}, \widehat{\beta}_5^{**})$ of these factors under CRS and VRS specifications are, respectively, (−0.394,−0.081) and (−0.285,−0.065). The positive impact of *Star rating* on technical efficiency is in line with the findings of Ray and Phillips (2005) as well as Assaf and Agbola (2011). Moreover, this result is practically consistent with the market parity between quality of service and room price (revenue), assuming that star rating reflects effectively the expected service quality.

6. Conclusions, implications and future research

The present study provided the first performance analysis of the hospitality industry in Oman based on a DEA-double bootstrap procedure. The point estimation of technical efficiency revealed that 13.8% and 37.9% of Oman's hotels are efficient under CRS and VRS assumptions, respectively. The interval estimation produced ranges of efficiency scores that are relatively narrow, which allowed us to attempt a ranking of the efficient hotels and distinguish Safeer Continental Hotel and Al-Shumukh Guest House as the best and the worst efficient hotels. The slack analysis showed that faster efficiency improvement might be achieved through expanding the outputs *Annual revenue, Number of guests*, and *Number of nights*. About 72.7% of the efficient hotels located in Muscat. Such a high concentration is probably due to the attractiveness of Muscat, being the capital of the country and the key business place. These facts, in spite of being positive indicators for potential investors, may also reflect strong centralization of current tourism operations. Indeed, the statistics of the Ministry of Tourism reveal that there are 54 hotels in the capital Muscat alone, with a lodging capacity of 4602

Table 6
Average required expansion of the outputs per inefficient hotel (VRS).

Output	Number of hotels	Surplus	Required expansion (%)
Annual revenue ($)	13	140,625.66	1.79
Number of guests	27	4228.54	1.63
Number of nights	21	4967.26	1.55
Occupancy rate (%)	8	29.03	25.77

Table 7
Interval width based ranking of the benchmark hotels.

Rank	Hotel		Location	Interval width	Efficiency variance
1	H18	Safeer Continental	Muscat	0.098	0.001
2	H52	Sohar Beach	Al-Batinah	0.122	0.001
3	H24	Safeer Hotel Suites	Muscat	0.156	0.002
4	H9	Radisson SAS	Muscat	0.218	0.023
5	H11	Majan Continental	Muscat	0.237	0.004
6	H7	Holiday	Muscat	0.241	0.005
7	H26	Star hotel apartments	Muscat	0.247	0.004
8	H15	Ruwi	Muscat	0.260	0.006
9	H30	Corniche	Muscat	0.287	0.005
10	H32	Hilton	Salalah	0.346	0.012
11	H8	Golden Tulip Seeb	Muscat	0.348	0.011
12	H41	Al Jawhara	Al Buraymi	0.432	0.018
13	H3	Grand Hyatt	Muscat	0.466	0.023
14	H40	Al Massa	Al Buraymi	0.472	0.023
15	H5	Barr Al Jissah Resort	Muscat	0.500	0.023
16	H4	The Chedi	Muscat	0.509	0.025
17	H16	Coral	Muscat	0.562	0.029
18	H31	Waffa Hotel Apartment	Muscat	0.577	0.029
19	H14	Ramee Dream Resort	Muscat	0.603	0.030
20	H28	Al-Hail	Muscat	0.681	0.034
21	H37	Al Nasr	Salalah	0.876	0.044
22	H57	Al-Shumukh guest house	Al-Batinah	0.878	0.043

Table 8
Results of the truncated double bootstrapped regression analysis.

Factor	*CRS*				*VRS*			
	$\hat{\beta}^{**}$	SE	Lower bound	Upper bound	$\hat{\beta}^{**}$	SE	Lower bound	Upper bound
Intercept	5.672	1.190	1.840	6.547	4.313	0.938	0.140	3.871
Type of ownership	0.077	0.867	−1.571	1.847	−0.131	0.651	−1.990	0.578
Hotel size	0.312	0.939	−0.986	2.680	0.291	0.720	−0.357	2.474
Star rating	**−0.394**	**0.377**	**−1.951**	**−0.456**	**−0.285**	**0.284**	**−1.541**	**−0.460**
Nature	**0.102**	**0.117**	**0.075**	**0.537**	0.050	0.097	−0.026	0.359
Culture	**−0.081**	**0.101**	**−0.438**	**−0.035**	**−0.065**	**0.082**	**−0.383**	**−0.058**
Activities	−0.089	0.139	−0.538	0.009	−0.013	0.117	−0.274	0.186

rooms (approximately 62% of the total capacity). Dhofar follows with 15 hotels and 914 rooms. The other regions, all together, host only 38 hotels, that is, about 25% of the total capacity. Henceforth, more measures ought to be taken to promote tourism in the other regions of the country, for example, through discount packages from airlines and hotels, targeting foreign and domestic tourists.

Potential factors of inefficiency have been investigated via truncated regression analysis using the double bootstrapping procedure suggested by Simar and Wilson (2007). The results showed that the factors *Type of ownership* (independent or chain dependent), *Hotel size*, *Nature* and *Activities* have no impact on the efficiency of a hotel, whilst *Star rating* and *Culture* appear as the most influential factors. The positive effect of *Culture* may also translate the dominant profile of hotels' customers. This can inform the marketing operations on the customers' populations to be targeted in order to promote other attractions, like *nature* and *activities*. These findings could also benefit the Omani government in the process of strategy improvement. Future strategies might focus on setting clear policies for the rehabilitation of the existing cultural heritage which consists of 748 major archaeological sites in addition to more than 2660 archaeological and historic buildings and landmarks over the country. Furthermore, incentive schemes might be developed to encourage construction of new hotels in areas close to cultural sites.

Future research may be enriched with more input and output variables, together with a horizon extension covering more than one year, so that the dynamics of the efficiency measures can be captured. In addition, one could consider incorporating all of the variables (discretionary and non-discretionary) into the same model using extended DEA models (e.g. Banker & Morey, 1986a,b).

References

Anderson, R. I., Fish, M., Xia, Y., & Michello, F. (1999). Measuring efficiency in the hotel industry: a stochastic frontier approach. *International Journal of Hospitality Management, 18*(1), 45–57.

Anderson, R. I., Fok, R., & Scott, J. (2000). Hotel industry efficiency: an advanced linear programming examination. *American Business Review, 18*(1), 40–48.

Assaf, A. G. (2012). Benchmarking the Asia Pacific tourism industry: a Bayesian combination of DEA and stochastic frontier. *Tourism Management, 33*, 1122–1127.

Assaf, A. G., & Agbola, F. (2011). Modelling the performance of Australian hotels: a DEA double bootstrap approach. *Tourism Economics, 17*(1), 73–89.

Assaf, A. G., & Barros, C. (2011). Performance analysis of the Gulf hotel industry: a Malmquist index with bias correction. *International Journal of Hospitality Management, 30*(4), 819–826.

Assaf, A. G., Barros, C. P., & Josiassen, A. (2010). Hotel efficiency: a bootstrapped metafrontier approach. *International Journal of Hospitality Management, 29*(3), 468–475.

Assaf, A. G., & Cvelbar, L. K. (2010). The performance of the Slovenian hotel industry: evaluation post-privatisation. *International Journal of Tourism Research, 12*(5), 462–471.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*(9), 1078–1092.

Banker, R. D., & Morey, R. C. (1986a). Efficiency analysis for exogenously fixed inputs and outputs. *Operations Research, 34*(4), 513–521.

Banker, R. D., & Morey, R. C. (1986b). The use of categorical variables in data envelopment analysis. *Management Science, 32*(12), 1613–1627.

Barros, C. P. (2004). A stochastic cost frontier in the Portuguese hotel industry. *Tourism Economics, 10*(2), 177–192.

Barros, C. P. (2005a). Evaluating the efficiency of a small hotel chain with a Malmquist productivity index. *The International Journal of Tourism Research, 7*(3), 173–184.

Barros, C. P. (2005b). Measuring efficiency in the hotel sector. *Annals of Tourism Research, 32*(2), 456–477.

Barros, C. P. (2006). Analyzing the rate of technical change in the Portuguese hotel industry. *Tourism Economics, 12*(3), 325–346.

Barros, C. P., Botti, L., Peypoch, N., & Solonandrasana, B. (2011). Managerial efficiency and hospitality industry: the Portuguese case. *Applied Economics, 43*(22), 2895–2905.

Barros, C. P., & Dieke, P. U. C. (2008). Technical efficiency of African hotels. *International Journal of Hospitality Management, 27*(3), 438–447.

Barros, C. P., & Mascarenhas, M. J. (2005). Technical and allocative efficiency in a chain of small hotels. *International Journal of Hospitality Management, 24*(3), 415–436.

Bell, R. A., & Morey, R. C. (1994). The search for appropriate benchmarking partners– a macro approach and application to corporate travel management. *Omega, 2*(5), 477–490.

Bell, R. A., & Morey, R. C. (1995). Increasing the efficiency of corporate travel management through macro benchmarking. *Journal of Travel Research, 33*(3), 11–20.

Bernini, C., & Guizzardi, A. (2010). Internal and locational factors affecting hotel industry efficiency: evidence from Italian business corporations. *Tourism Economics, 16*(4), 883–913.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2*(6), 429–444.

Chen, C. F. (2007). Applying the stochastic frontier approach to measure hotel managerial efficiency in Taiwan. *Tourism Management, 28*(3), 696–702.

Chen, C. T., Hu, J. L., & Liao, J. J. (2010). Tourists' nationalities and the cost efficiency of international tourist hotels in Taiwan. *African Journal of Business Management, 4*(16), 3440–3446.

Chiang, W., Tsai, M., & Wang, L. S. (2004). A DEA evaluation of Taipei hotels. *Annals of Tourism Research, 31*(3), 712–775.

Chin, J. B., Wu, M. C., & Hsieh, L. F. (2013). Strategic planning of optimal resource allocation in response to global financial crisis – a study of international tourist hotels. *Applied Economics, 45*(23), 3316–3328.

Chiu, Y., Huang, C., & Ting, C. (2012). A non-radial measure of different systems for Taiwanese tourist hotels' efficiency assessment. *Central European Journal of Operations Research, 20*(1), 45–63.

Choufany, H. M., & Younes, E. (2005). *Oman today's spotlight, tomorrow's destination*. HVS International London. available at: http://www.hvs.com/Content/1687.pdf.

Coelli, T., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An Introduction to efficiency and productivity analysis*. New York: Springer.

Cook, W. D., Tone, K., & Zhu, J. (2014). Data envelopment analysis: prior to choosing a model. *Omega, 44*(1), 1–4.

Cooper, W. W., Seiford, L. M., & Tone, H. (2002). *Data envelopment analysis: A comprehensive text with models, applications, references, and DEA-Solver software*. N.Y: Kluwer Academic Publisher.

Fang, C. Y. (2013). Did the financial crisis and policy deregulation for Chinese tourists affect the efficiency and output slacks of Taiwanese hotels? In A. Matias, P. Nijkamp, & M. Sarmento (Eds.), *Quantitative methods in tourism economics*. Springer-Verlag Berlin Heidelberg.

Gomezelj, O., & Mihalič, T. (2008). Destination competitiveness – applying different models, the case of Slovenia. *Tourism Management, 29*(2), 294–307.

Greene, W. (2008). The econometric approach to efficiency analysis. In H. O. Fried, C. A. K. Lovell, & S. S. Schmidt (Eds.), *The measurement of productive efficiency and productivity growth*. Oxford University Press.

Hadad, Y., Friedman, L., & Israeli, A. A. (2005). Evaluating hotel advertisements efficiency using data envelopment analysis. *Journal of Business Economics and Management, 6*(3), 145–153.

Hathroubi, S., Peypoch, N., & Robinot, E. (2014). Technical efficiency and environmental management: the Tunisian case. *Journal of Hospitality and Tourism Management, 21*(1), 27–33.

Honma, S., & Hu, J. L. (2012). Analyzing Japanese hotel efficiency. *Tourism & Hospitality Research, 12*(3), 155–167.

Hruschka, H. (1986). Ansätze der efflzienzmessung von betrieben. *Journal für Betriebswirtschaft : Management Review Quarterly, 36*(2), 76–85.
Huang, C., Ho, F. N., & Chiu, Y. (2014). Measurement of tourist hotels' productive efficiency, occupancy, and catering service effectiveness using a modified two-stage DEA model in Taiwan. *Omega, 48*, 49–59.
Huang, Y., Mesak, H. I., Hsu, M. K., & Qu, H. (2012). Dynamic efficiency assessment of the Chinese hotel industry. *Journal of Business Research, 65*(1), 59–67.
Hu, J. L., Chiu, C. N., Shieh, H. S., & Huang, C. H. (2010). A stochastic cost efficiency analysis of international tourist hotels in Taiwan. *International Journal of Hospitality Management, 29*(1), 99–107.
Hu, J. L., Shieh, H. S., Huang, C. H., & Chiu, C. N. (2009). Cost efficiency of international tourist hotels in Taiwan: a data envelopment analysis application. *Asia Pacific Journal of Tourism Research, 14*(4), 371–384.
Hu, J. L., Yeh, F. Y., & Tsai, Y. C. (2014). Regional traffic and medical services and cost efficiency of international tourist hotels in Taiwan. *International Business Research, 7*(10), 36–46.
Hwang, S. N., & Chang, T. Y. (2003). Using data envelopment analysis to measure hotel managerial efficiency change in Taiwan. *Tourism Management, 24*(4), 357–369.
Jeong, S. O., Park, B. U., & Simar, L. (2010). Nonparametric conditional efficiency measures: asymptotic properties. *Annals of Operational Research, 173*, 105–122.
Keh, H. T., Chu, S., & Xu, J. (2006). Efficiency, effectiveness and productivity of marketing in services. *European Journal of Operational Research, 170*(1), 265–276.
Liu, J. S., Lu, L. Y. Y., Lu, W. M., & Lin, B. J. Y. (2013). A Survey of DEA applications. *Omega, 41*(5), 893–902.
Manasakis, C., Apostolakis, A., & Datseris, G. (2013). Using data envelopment analysis to measure hotel efficiency in Crete. *International Journal of Contemporary Hospitality Management, 25*(4), 510–535.
Min, H., Min, H., & Joo, S. J. (2009). A data envelopment analysis on assessing the competitiveness of Korean hotels. *The Service Industries Journal, 29*(3), 367–385.
Morey, R., & Dittman, D. (1995). Evaluating a hotel GM's performance: a case study in benchmarking. *Cornell Hotel and Restaurant Administration Quarterly, 36*(5), 30–35.
Neves, J., & Lourenco, S. (2009). Using data envelopment analysis to select strategies that improve the performance of hotel companies. *International Journal of Contemporary Hospitality Management, 21*(6), 698–712.
Oliveira, R., Pedro, M. I., & Marques, R. C. (2013). Efficiency and its determinants in Portuguese hotels in the Algarve. *Tourism Management, 36*, 641–649.
Önüt, S., & Soner, S. (2006). Energy efficiency assessment for the Antalya Region hotels in Turkey. *Energy and Buildings, 38*(8), 964–971.
Oukil, A., & Al-Zaidi, A. (2014). Benchmarking the hotel industry in Oman through a three-stage DEA-based procedure. In *Proceedings of the VII International Tourism Congress*. Muscat: Sultanate of Oman.
Perrigot, R., Cliquet, G., & Piot-Lepetit, I. (2009). Plural form chain and efficiency: insights from the French hotel chains and the DEA methodology. *European Management Journal, 27*(4), 268–280.
Pulina, M., Detotto, C., & Paba, A. (2010). An investigation into the relationship between size and efficiency of the Italian hospitality sector: a window DEA approach. *European Journal of Operational Research, 204*(3), 613–620.
QNB. (2013). *Oman economic insight 2013*. Qatar National Bank. available at: http://www.qnb.com.qa/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1355479823300&ssbinary=true.
Ray, P., & Phillips, P. (2005). Performance comparisons of hotels in China. *International Journal of Hospitality Management, 24*(1), 57–73.
Reynolds, D. (2003). Hospitality-productivity assessment using data envelopment analysis. *Cornell Hotel and Restaurant Administration Quarterly, 44*(2), 130–137.
Shang, J., Wang, F., & Hung, W. (2010). A stochastic DEA study of hotel efficiency. *Applied Economics, 42*(19), 2505–2518.
Shirouyehzad, H., Hosseinzadeh Lotfi, F., Shahin, A., Aryanezhad, M. B., & Dabestani, R. (2012). A DEA approach for comparative analysis of service quality dimensions with a case study in hotel industry. *International Journal of Services & Operations Management, 12*(3), 289–308.
Sigala, M., Jones, P., Lockwood, A., & Airey, D. (2005). Productivity in hotels: a stepwise data envelopment analysis of hotels' rooms division processes. *The Service Industries Journal, 25*(1), 61–81.
Simar, L., & Wilson, P. (1998). Sensitivity analysis of efficiency scores: how to bootstrap in nonparametric frontier models. *Management Science, 44*(1), 49–61.
Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics, 136*(1), 31–64.
Subramoniam, S., Al-Essai, S. A. N., Al-Marshadi, A. A. M., & Al-Kindi, A. M. A. (2010). SWOT analysis on Oman tourism: a case study. *Journal of Economics Development, Management, IT, Finance and Marketing, 2*(2), 1–22.
Sun, S., & Lu, W. M. (2005). Evaluating the performance of the Taiwanese hotel industry using a weight slacks-based measure. *Asia Pacific Journal of Operational Research, 22*, 487–512.
Tarim, Ş., Dener, H. I., & Tarim, Ş. A. (2000). Efficiency measurement in the hotel industry: output factor constrained DEA application. *Anatolia: An International Journal of Tourism & Hospitality Research, 11*(2), 111–123.
Ting, C. T., & Huang, C. W. (2012). Measuring the effectiveness of mutual learning for Taiwan's tourist hotels with the DEA approach. *Cornell Hospitality Quarterly, 53*(1), 65–74.
Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica, 26*(1), 24–36.
Tumer, N. (2010). Measuring hotel performance using data envelopment analysis. *Anatolia: An International Journal of Tourism & Hospitality Research, 21*(2), 271–287.
Tundis, E., Corsino, M., & Zaninotto, E. (2012). *Revealing the influence of managerial practices and entrepreneurs' characteristics on hotel efficiency*. DISA Working Papers. Italy: Trento University.
WEF. (2013). The travel and tourism competitiveness report 2013. *World Economic Forum*, 276–277. Available at: http://www3.weforum.org/docs/WEF_TT_Competitiveness_Report_2013.pdf.
Winckler, O. (2007). The birth of Oman's tourism industry. *Tourism – An Interdisciplinary Journal, 55*(2), 221–234.
Wöber, K. W. (2007). Data envelopment analysis. *Journal of Travel & Tourism Marketing, 21*(4), 91–108.
WTTC. (2016). *Travel & tourism economic impact 2016*. Oman: World Travel & Tourism Council, 1-1, Available at: http://www.wttc.org/-/media/files/reports/economic%20impact%20research/countries%202016/oman2016.pdf.
Yang, C., & Lu, W. M. (2006). Performance benchmarking for Taiwan's international tourist hotels. *INFOR, 44*(3), 229–245.

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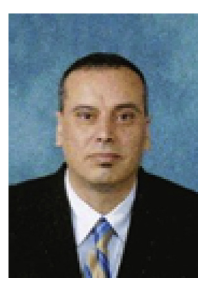

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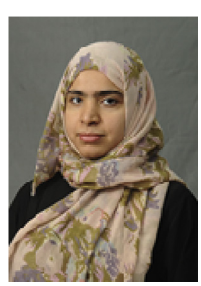

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