African Journal of Business Management Vol. 6(19), pp. 5957-5968, 16 May, 2012
Available online at http://www.academicjournals.org/AJBM
DOI: 10.5897/AJBM11.1540
ISSN 1993-8233 ©2012 Academic Journals

*Full Length Research Paper*

# An examination of the operating efficiency of international tourist hotels in Taiwan and associated factors

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Accepted 17 October, 2011

**This study examines the operating efficiency of international tourist hotels in Taiwan. Data envelopment analysis (DEA) is used to evaluate the relative efficiency management of chain and independent tourist hotels based on data from 2006 and 2007, allowing for the comparison of competitiveness between the different categories of international tourist hotels. Tobit regression analysis is used to assess whether factors such as the operating model and guest nationality have a significant impact on the operating efficiency, providing a basis for true improvement. Research results show that chain and independent international tourist hotels have exhibited significant improvements in terms of scale efficiency. While independently operated tourist hotels did improve significantly in overall efficiency and pure management efficiency, chain tourist hotels did not show significant improvements in these measures. In terms of the impact of environmental variables on efficiency, the hotel-operating model and guest nationality did have a significant positive impact on the overall efficiency.**

**Key words:** Efficiency, data envelopment analysis, Tobit regression analysis.

## INTRODUCTION

Barriers to travel have gradually diminished as the global economy has developed rapidly, resulting in an increase of international tourism. The tourism industry has become a primary source of foreign income for many countries. In response to globalization, Taiwan launched the “Doubling Tourist Arrivals Plan” in 2002. This plan facilitated the growth of the number of tourists visiting Taiwan from 2,977,692 in 2002 to 3,845,187 in 2008 and an increase in foreign income from $4,584 million USD to $5,936 million USD over the same period. Following the tourism trend in Taiwan, domestic and foreign hotel groups have seized on the business opportunities, investing in tourist hotels and establishing operations associated with international hotel chains.

Beginning in 1989, domestic tourist hotels became increasingly oriented towards cooperation and joint operations with internationally known hotel chains. For example, the Grand Hyatt Taipei, the Westin Taipei, Gloria Prince Hotel, and Caesar Park Hotel Kenting introduced management techniques and talent from Western hotels, improving the operation management capabilities of domestic tourist hotels. The number of tourists visiting Taiwan exceeded 3 million in 2005, bringing room occupancy rates in Taiwan to 73.54%; room prices approached $3,000 TWD/night, marking a high point compared to the previous several years.

However, due to the slowing growth of tourism among Taiwanese nationals and foreign citizens, room occupancy rates in international tourist hotels dropped to 70.21% in 2006, a drop of 3.33% compared to 2005 figures. In response to the business opportunities of catering to tourists from mainland China, the number of international tourist hotels in Taiwan expanded to 60 locations by 2007, with a total of 17,733 rooms. Nonetheless, overall room occupancy rates in international tourist hotels have continued to decline over

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the past few years, decreasing from 72% in 2005 to 67.16% in 2007. These figures show that overall supply is growing very rapidly. Relying solely on domestic demand will likely lead to oversupply, causing fierce competition in the hotel market. Therefore, measuring operating efficiency to increase competitive advantage and establish benchmarks is an important issue that operators of international tourist hotels must confront.

Topics related to the measurement of efficiency have been an important focus in various fields for some time now. Data envelopment analysis (DEA), one approach to measuring efficiency, uses linear planning techniques to estimate technological efficiency. The greatest advantage of this approach is its ability to process problems under multiple output conditions. Morey and Dittman (1995) were the first to use DEA to examine the operating efficiency of the hotel market. They found that the average operating efficiency of a hotel general manager was 89%; the general manager with the lowest efficiency had an efficiency of 64%.

Anderson et al. (2000) utilized DEA to measure the operating efficiency of 48 hotels in the United States. Their results showed that overall efficiency (OE) reached only 42%, primarily because of deficiencies in technical efficiency (TE) and allocative efficiency (AE). In other words, more efficient units allocated additional resources to other operations in the food service industry; therefore, managers should pay greater attention to the allocation of resources rather than the management of resources.

Hwang and Chang (2003) utilized the DEA model developed by Charnes et al. (1978) and the Malmquist productivity index by Farrell (1957) to assess the operating efficiency of 45 international tourist hotels in Taiwan during 1998 as well as changes in efficiency from 1994 to 1998. Sun (2004) utilized an output-oriented window analysis to assess the operating efficiency of 47 international tourist hotels in Taiwan from 1997 to 2001.

Barros (2005) conducted production capacity analysis of the operating efficiency of 42 hotels in Portugal. Firstly, the Malmquist index was used to differentiate between changes in technological efficiency (TE) and changes in efficiency caused by technological reasons. Changes in technological efficiency can be divided into pure technological changes and changes in scalar efficiency. Secondly, a Tobit regression model was used to examine the variables that may influence operating efficiency in hotels.

Chen (2006) utilized cost efficiency to assess the operating efficiency of 55 tourist hotels in 2002. This study yielded empirical results that suggested average efficiency was approximately 80%. Botti et al. (2007) utilized DEA to assess the operating efficiency of chain hotels based on 16 French plural form hotels, determining that the operating efficiency of plural form hotels was superior to that of hotel chain systems that open franchises or operate direct chain subsidiaries.

Barros and Dieke (2008) utilized DEA to assess the TE of 12 hotels in Luanda, Angola from 2000 to 2006, determining that efficiency increased during the research period but the rate of change slowed. In addition, the efficiency of hotels that joined member chains tended to increase. Efficiency gains were particularly pronounced when globalized strategies were adopted.

In summarizing the literature described previously, it can be determined that DEA has substantial reliability and validity in efficiency assessment. However, previous literature has rarely examined the impact of operating environment variables on the operating efficiency of international tourist hotels. As hotel chains become increasingly globalized and personal consumption awareness increases, the comparison between chain and independent hotels becomes important to assess the efficiency measure of hotel competitiveness, but existing literature is somewhat sparse.

Accordingly, this study attempts to use international tourist hotels in Taiwan as a subject to perform a comparison between chain and independent hotels for 2006 and 2007. DEA is used to measure relative efficiency to perform a comparison of competitive strength among international tourist hotels. Tobit regression is used to examine the influence of factors such as operating form, locality, scale, target customer segment, and guest nationality on operating efficiency increases. The results of this study should provide a basis for making genuine improvements, creating new opportunities for international tourist hotels in Taiwan.

## RESEARCH METHODS

This study utilizes two-stage DEA to perform analysis. The first stage utilizes DEA to measure the management efficiency of different hotels types and then uses Wilcoxon signed-rank test to determine whether the average efficiency is increasing or declining. The second stage utilizes a Tobit regression empirical model to assess whether the hotel operating form, locality, scale category, target customer segment, and guest nationality significantly influence efficiency improvements and to reflect the impact of environmental variables on efficiency.

### Examination of data envelopment analysis (DEA) efficiency assessment model

Theories related to the measurement of efficiency originated with Farrell, who introduced production frontiers as a basis for measuring efficiency in 1957 and used efficient frontier to assess the TE and AE of decision-making units (DMU). Production frontiers are measured using the two following methods: (1) the stochastic frontier approach (SFA), which is an application of the parameter method; this approach defines the target function of a DMU and the distribution of random interference terms to perform an efficiency assessment; (2) DEA, a non-parameter method application, has the advantage of not requiring preset input-output function relationships or preset factor weighting, making it more suitable for measuring the efficiency of organizations with multiple inputs and outputs.

DEA can be divided into the CCR and BCC models. The CCR model, introduced by Charnes et al. (1978) expands the “two inputs, one output” concept of Farrell to the “multiple inputs, multiple outputs” analysis model and produces a measurement of efficiency based on an assumption of constant returns

to scale (CRS) in the production process. The measurement of efficiency is performed using the following formula:

**CCR model**

In this model, $\lambda_j$ is the factor weighting; $S_i^-$ and $S_r^+$ are the slack variables for the inputs and outputs. In addition, θ is the $TE^{CRS}$ of the $k^{th}$ DMU under CRS for the input side; the efficiency value ranges from 0 to 1. If θ = 1, $S_i^- = 0$, and $S_r^+ = 0$, then the DMU is located on the efficiency frontier and has achieved TE; if θ is close to 0, then the DMU is inefficient.

$$\text{Min} \quad E_k = \theta_k - \varepsilon \left[ \sum_{i=1}^{m} s_i^- - \sum_{r=1}^{p} s_r^+ \right]$$

$$\text{Subject to} \quad \theta_k X_{ik} - \sum_{j=1}^{n} \lambda_j X_{ij} = s_i^-$$

$$\sum_{j=1}^{n} \lambda_j Y_{rj} - Y_{rk} = s_r^+$$

$\lambda_j, S_i^-, S_r^+ \geq 0$, j = 1,…., n, i = 1,…., m, r = 1,…., p
$X_{ij}$: the number of $i^{th}$ inputs for the $j^{th}$ DMU;
$Y_{rj}$: the number of $r^{th}$ outputs of the $j^{th}$ DMU.

**BCC model**

The BCC model was introduced by Banker et al. (1984) and applies to the distance function concept developed by Shephard (1970). The assumption of CRS in the CCR model is changed to an assumption of variable returns to scale (VRS). TE is divided into pure technical efficiency (PTE) and scale efficiency (SE) to determine the sources of inefficiency. The BCC model is expressed using the following model:

$$\text{Min} \quad E_k = \theta_k - \varepsilon \left[ \sum_{i=1}^{m} s_i^- - \sum_{r=1}^{p} s_r^+ \right]$$

$$\text{Subject to} \quad \theta_k X_{ik} - \sum_{j=1}^{n} \lambda_j X_{ij} = s_i^-$$

$$\sum_{j=1}^{n} \lambda_j Y_{rj} - Y_{rk} = s_r^+$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$\lambda_j, S_i, S_r^+ \geq 0$, j = 1,…., n, i = 1,…., m, r = 1,…., p

The BCC model includes an additional convexity constraint $\sum \lambda_j = 1$ compared to CCR. The BCC model measures pure TE, whereas the CCR model measures overall TE; the two measures of TE differ in scale efficiency. Banker (1984) demonstrated that TE is the product of pure TE and SE. In other words, technological inefficiency may result from inefficiency in the impact of production technology and inefficiency resulting from the impact of the DMU not being positioned at the optimal scale.

**Tobit regression empirical model**

This study aims to examine whether the factors of the hotel operating form, locality, scale, target customer segment, or guest nationality significantly influence increases in operating efficiency. Results should provide a basis for true improvements in operating efficiency. Therefore, Tobit regression analysis, as introduced by Tobit (1958) is used for the second stage.

Two-stage DEA methodology typically involves the use of DEA to measure efficiency in the first stage and uses a Tobit regression empirical model in the second stage to analyze efficiency as a dependent (explained) variable with environmental variables and as an independent variable. Whether the environmental variables significantly influence efficiency increases is assessed, reflecting the influence direction of environmental variables on efficiency.

In selecting environmental variables, this study primarily considered the operating characteristics of domestic hotels and, based on the methods of Barros (2005) with regard to the hotel industry, selected the factors of operating form, locality, scale, target customer segment, and guest nationality as regression variables to be assessed for whether they significantly influence increases in operating efficiency. The model used in this study is as follows:

$$E_k = \beta_0 + \beta_i Z_i + \varepsilon_k \quad (i = 1,\ldots, 5)$$

$E_k$: the overall TE of the $k^{th}$ DMU, $Z_1$: operating form, $Z_2$: locality, $Z_3$: scale, $Z_4$: target customer segment, $Z_5$: guest nationality, $\varepsilon_k$: regression error.

Therefore, the operating form was divided into chain and independent international tourist hotels based on operations in Taiwan. If a hotel is a member of an international hotel chain group, then $Z_1 = 1$; conversely, $Z_1 = 0$ for independent hotels. International tourist hotels were divided by locality into the regions of Taipei, Kaohsiung, Taichung, Hualien, and Hsinchu/Taoyuan/Miaoli. If the hotel was located in the Taipei region, then $Z_2 = 1$; if the hotel was located in the Kaohsiung region, then $Z_2 = 2$; if the hotel was located in the Taichung region, then $Z_2 = 3$; if the hotel was located in the Hualien region, then $Z_2 = 4$; if the hotel was located in the Hsinchu/Taoyuan/Miaoli region, then $Z_2 = 5$; if the hotel was located in another region, then $Z_2 = 6$.

The scale of a hotel was determined based on the number of rooms. For a hotel with over 400 rooms, $Z_3 = 1$; for a hotel with 250 to 399 rooms, $Z_3 = 2$; for a hotel with less than 249 rooms, $Z_3 = 3$. The primary customer segments for international tourist hotels in Taiwan were tourists and business travelers. If a hotel's primary customer segment was business travelers, then $Z_4 = 1$; if a hotel's primary customer segment was tourists, then $Z_4 = 0$. For guest nationality, if over 50% of a hotel's guests were foreign citizens, then $Z_5 = 1$; if not, then $Z_5 = 0$.

## EMPIRICAL ANALYSIS AND RESULTS

This study used international tourist hotels in 2006 and 2007 as the research subjects; the subjects were divided into the two categories of chain and independently-operated hotels for analysis. Since data was incomplete for some tourist hotels, this study was limited to 56 international tourist hotels. The source of the data for this study was the annual "Operating Report of International Tourist Hotels in Taiwan" issued by the Tourism Bureau, Ministry of Transportation and

Communication in 2006 and 2007.

**Variable selection and explanation**

This study considered the operating characteristics of domestic hotels and consulted literature relevant to the hotel industry in selecting the following four input variables and one output variable, as explained subsequently:

***Input variables***

1. Number of rooms (unit: room): Refers to the amount of guest rooms of a given hotel; the number of rooms in a hotel determines the income from hotel guest rooms; guest rooms are also a fixed asset. The number of rooms in a hotel was included as an input variable.
2. Total floor area of the food services department (unit: *pyeong*): Refers to the total floor area occupied by restaurants, banquet halls, and cafés in a hotel. In recent years, income from food and beverage services has exceeded income from guest rooms; the total area of floor space allocated to food services determines the income from food and beverage services, and so must be included as an input.
3. Number of Employees (unit: person): Refers to the number of individuals employed in the guest room department, food and beverage department, and management. The hotel industry is a labor-intensive industry and is characterized by a strong demand for labor. Therefore, this study includes the number of employees as an input.
4. Total operating expenditure (unit: New Taiwan Dollar/Yuan): Total operating expenditures can be viewed the total costs; the amount of total costs has a decisive impact on operating income. Total operating expenditures can be divided primarily into the categories of salaries and related fees, food and beverage costs, utilities fees, depreciation, maintenance costs, and laundry costs.

***Output variables***

Total operating income (unit: New Taiwan Dollar/Yuan): The production value of hotel operations is measured primarily using total operating income. Total operating income can be divided into guest room income, food and beverage income, laundry income, storefront rental income, auxiliary operations income, services income, and other income.

**Environmental variables**

$E_k = \beta_0 + \beta_i Z_I + \varepsilon_k \ (i = 1, \ldots, 5)$

$E_k$: Overall technical efficiency of the $k^{th}$ DMU, $Z_1$: The operating form, a dummy variable indicating whether a hotel is a member of an international hotel chain group, if so, then $Z_1$=1; if the hotel is an independently operated hotel, then $Z_1 = 0$. $Z_2$: The geographical location, if the hotel was located in the Taipei region, then $Z_2$=1; if the hotel was located in the Kaohsiung region, then $Z_2 = 2$; if the hotel was located in the Taichung region, then $Z_2 = 3$; if the hotel was located in the Hualien region, then $Z_2 = 4$; if the hotel was located in the Hsinchu/Taoyuan/Miaoli region, then $Z_2 = 5$; if the hotel was located in another region, then $Z_2 = 6$. $Z_3$: The scale, for a hotel with over 400 rooms, $Z_3 = 1$; for a hotel with 250 to 399 rooms, $Z_3 = 2$; for a hotel with less than 249 rooms, $Z_3 = 3$. For guest nationality, if over 50% of a hotel's guests were foreign citizens, then $Z_5 = 1$; if not, then $Z_5 = 0$. $Z_4$: The target customer segment, a dummy variable; if a hotel's primary customer segment was business travelers, then $Z_4 = 1$; if a hotel's primary customer segment was tourists, then $Z_4 = 0$. $Z_5$: The guest nationality, a dummy variable; if over 50 % of a hotel's guests were foreign nationals, then $Z_5 = 1$; if not, then $Z_5 = 0$.

**Pearson correlation coefficient test**

This study divided international tourist hotels into the two categories of chain hotels and independent hotels. The Pearson correlation coefficient was first used to test whether the relationships between the inputs and outputs of the two hotel categories were consistent with the assumption of isotonicity, or the assumption that an increase in input would not lead to a decrease in output. The results of the Pearson correlation test analysis of annual input and output data are shown in Table 1.

It can be seen from Table 1 that the relationships between the input variables and the output variable are both positive and pass the two-tailed test of significance at the 1% level for chain as well as independent hotels, indicating a significant correlation between the variables. Therefore, it can be inferred that the input and output variables selected for this study are reasonable and appropriate for the DEA model.

**Efficiency analysis**

This study examines the operating efficiency of chain and independent international tourist hotels in 2006 and 2007, measuring the overall efficiency, pure management efficiency, and scale efficiency and comparing rankings between the two years to assess the competitive strength of the hotels. The Wilcoxon signed-rank test was also conducted to determine whether the various average efficiency levels exhibited positive or negative trends.

**Overall efficiency analysis**

***Chain hotels***

As shown in Table 2, the Caesar Park Hotel Taipei, Grand

**Table 1.** Pearson correlation test.

| | | Rooms | Floor space | Employee | Costs |
|---|---|---|---|---|---|
| **Revenues** | Chain hotels | 0.869** | 0.455** | 0.939** | 0.958** |
| | Independent hotels | 0.583** | 0.748** | 0.959** | 0.990** |

** indicates significant correlation at the 0.01 level (two-tailed).

**Table 2.** Efficiency and ranks of chain tourist hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | TE | Rank | TE | Rank |
| The Ambassador Hotel | 0.840 | 9 | 0.826 | 10 |
| Gloria Prince Hotel | 1.000 | 1 | 0.992 | 7 |
| Caesar Park Hotel Taipei | 1.000 | 1 | 1.000 | 1 |
| The Landis Taipei Hotel | 0.780 | 13 | 0.757 | 16 |
| Sheraton Taipei Hotel | 0.782 | 12 | 0.848 | 9 |
| Hotel Royal Taipei | 0.823 | 11 | 0.783 | 15 |
| Howard Plaza Hotel | 0.826 | 10 | 0.800 | 12 |
| Grand Hyatt Taipei | 1.000 | 1 | 1.000 | 1 |
| Grand Formosa Regent Taipei | 1.000 | 1 | 1.000 | 1 |
| The Sherwood Hotel Taipei | 1.000 | 1 | 1.000 | 1 |
| Far Eastern Plaza Hotel (Taipei) | 0.912 | 7 | 1.000 | 1 |
| The Westin Taipei | 1.000 | 1 | 0.950 | 8 |
| The Ambassador Hotel Kaohsiung | 0.589 | 24 | 0.608 | 23 |
| Howard Plaza Hotel Kaohsiung | 0.612 | 23 | 0.651 | 19 |
| The Splendor, Kaohsiung | 0.554 | 26 | 0.537 | 25 |
| Howard Plaza Hotel Taichung | 0.694 | 17 | 0.690 | 18 |
| The Splendor Hotel | 0.641 | 22 | 0.515 | 26 |
| Chinatrust Hotel (Hualien) | 0.577 | 25 | 0.599 | 24 |
| Hotel Landis China Yangmingshan | 0.749 | 16 | 0.786 | 13 |
| Caesar Park Hotel Kenting | 0.881 | 8 | 1.000 | 1 |
| Howard Beach Resort Kenting | 0.688 | 18 | 0.637 | 21 |
| Hotel Royal Chihpen Spa | 0.776 | 14 | 0.740 | 17 |
| Grand Formosa Hotel, Taroko | 0.538 | 27 | 0.507 | 27 |
| Hotel Royal Chiao-his | 0.753 | 15 | 0.785 | 14 |
| Hotel Royal Hsinchu | 0.660 | 19 | 0.648 | 20 |
| The Ambassador Hotel Hsinchu | 0.646 | 21 | 0.804 | 11 |
| Tayih Landis Tainan | 0.654 | 20 | 0.627 | 22 |

Hyatt Taipei, Grand Formosa Regent Taipei, and The Sherwood Hotel Taipei were ranked first in both years. The rankings of the Far Eastern Plaza Hotel (Taipei) and Sheraton Taipei Hotel also improved substantially. Conversely, the rankings of Gloria Prince Hotel, and The Westin Taipei dropped significantly. The Ambassador Hotel Kaohsiung was ranked last in both years.

### *Independently-operated hotels*

As shown in Table 3, The Lalu Sun Moon Lake and Evergreen Laurel Hotel (Taichung) ranked in the top three both years. The rankings of the Astar Hotel, Evergreen Plaza Hotel (Tainan), and Hotel Kingdom rose substantially. The Hotel National and Plaza International Hotel dropped significantly in the rankings. The Hibiscus Resort and The Grand Hotel Kaohsiung were ranked at the bottom in both years.

### Wilcoxon signed-rank test

This study utilized the Wilcoxon signed-rank test to

**Table 3.** Efficiency and rankings of independently-operated hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | TE | Rank | TE | Rank |
| The Grand Hotel | 0.720 | 17 | 0.801 | 12 |
| Imperial Hotel Taipei | 0.690 | 22 | 0.694 | 26 |
| Emperor Hotel | 0.710 | 19 | 0.718 | 23 |
| Hotel Riverview Taipei | 0.845 | 5 | 0.920 | 6 |
| Golden China Hotel | 0.805 | 9 | 0.828 | 10 |
| San Want Hotel | 0.773 | 13 | 0.844 | 8 |
| Brother Hotel | 0.727 | 16 | 0.776 | 18 |
| Santos Hotel | 0.815 | 8 | 0.807 | 11 |
| United Hotel | 0.898 | 3 | 0.948 | 4 |
| Hotel Kingdom | 0.709 | 21 | 0.800 | 13 |
| Hotel Holiday Garden Kaohsiung | 0.774 | 12 | 0.748 | 19 |
| Grand Hi-Lai Hotel | 0.829 | 7 | 0.942 | 5 |
| Han-Hsien International Hotel | 0.682 | 24 | 0.728 | 22 |
| Royal Lees Hotel | 0.744 | 15 | 0.790 | 14 |
| Hotel National | 0.836 | 6 | 0.738 | 21 |
| Plaza International Hotel | 0.803 | 10 | 0.781 | 16 |
| Evergreen Laurel Hotel (Taichung) | 1.000 | 1 | 0.970 | 3 |
| Astar Hotel | 0.631 | 27 | 1.000 | 1 |
| Marshal Hotel | 0.710 | 20 | 0.709 | 25 |
| Parkview Hotel | 0.713 | 18 | 0.742 | 20 |
| Farglory Hotel, Hualien | 0.772 | 14 | 0.840 | 9 |
| The Lalu Sun Moon Lake | 1.000 | 1 | 1.000 | 1 |
| The Hibiscus Resort | 0.569 | 28 | 0.557 | 29 |
| The Grand Hotel Kaohsiung | 0.559 | 29 | 0.574 | 28 |
| Taoyuan Hotel | 0.876 | 4 | 0.881 | 7 |
| Ta Shee Resort Hotel | 0.661 | 25 | 0.679 | 27 |
| Hotel Tainan | 0.801 | 11 | 0.777 | 17 |
| Evergreen Plaza Hotel (Tainan) | 0.657 | 26 | 0.783 | 15 |
| Formosa Naruwan Hotel and Resort Taitung | 0.687 | 23 | 0.710 | 24 |

determine whether the average overall efficiency ($\overline{TE}$) exhibited significant improvement; therefore, the null hypothesis ($H_0$) and the alternative hypothesis ($H_1$) are expressed as described subsequently (Table 4):

$H_0$: $\overline{TE}_{2007} \leq \overline{TE}_{2006}$

$H_1$: $\overline{TE}_{2007} > \overline{TE}_{2006}$

Based on a significance level of α = 1%, it can be determined that there were significant changes in the average overall efficiency of independently-operated hotels, so the test results lead to the rejection of $H_0$; as such, there was a trend of improvement. However, $H_0$ was accepted for chain hotels, so $\overline{TE}$ did not exhibit a significant trend of improvement.

**Pure management efficiency analysis**

***Chain hotels***

It can be seen in Table 5 that the Caesar Park Hotel Taipei, Grand Hyatt Taipei, Grand Formosa Regent Taipei, The Sherwood Hotel Taipei, Gloria Prince Hotel, and Hotel Landis China Yangmingshan were ranked first in both years. The Ambassador Hotel Hsinchu, Far Eastern Plaza Hotel (Taipei), Sheraton Taipei Hotel, and Caesar Park Hotel Kenting had their rankings improve significantly; the rank of The Westin Taipei dropped substantially. The Splendor, Kaohsiung was ranked last in both years.

***Independently-operated hotels***

Table 6 shows that the Emperor Hotel, San Want Hotel, Grand Hi-Lai Hotel, Astar Hotel, and The Lalu Sun Moon

**Table 4.** Wilcoxon test for $\overline{TE}$ of different hotel categories.

| Variable | Chain hotels | Independent hotels |
|---|---|---|
| Z test (Wilcoxon score) | -0.030 | -2.676** |
| P-value | 0.488 | 0.0035 |

** indicates test results at the significance level of α = 1%.

**Table 5.** Pure technical efficiency and rankings of chain hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | PTE | Rank | PTE | Rank |
| The Ambassador Hotel | 0.847 | 12 | 0.832 | 14 |
| Gloria Prince Hotel | 1.000 | 1 | 1.000 | 1 |
| Caesar Park Hotel Taipei | 1.000 | 1 | 1.000 | 1 |
| The Landis Taipei Hotel | 0.817 | 14 | 0.791 | 17 |
| Sheraton Taipei Hotel | 0.783 | 17 | 0.849 | 10 |
| Hotel Royal Taipei | 0.887 | 10 | 0.837 | 13 |
| Howard Plaza Hotel | 0.840 | 13 | 0.811 | 15 |
| Grand Hyatt Taipei | 1.000 | 1 | 1.000 | 1 |
| Grand Formosa Regent Taipei | 1.000 | 1 | 1.000 | 1 |
| The Sherwood Hotel Taipei | 1.000 | 1 | 1.000 | 1 |
| Far Eastern Plaza Hotel (Taipei) | 0.953 | 9 | 1.000 | 1 |
| The Westin Taipei | 1.000 | 1 | 0.994 | 9 |
| The Ambassador Hotel Kaohsiung | 0.624 | 26 | 0.636 | 24 |
| Howard Plaza Hotel Kaohsiung | 0.661 | 25 | 0.697 | 20 |
| The Splendor, Kaohsiung | 0.580 | 27 | 0.562 | 27 |
| Howard Plaza Hotel Taichung | 0.793 | 16 | 0.784 | 18 |
| The Splendor Hotel | 0.701 | 22 | 0.611 | 26 |
| Chinatrust Hotel (Hualien) | 0.746 | 19 | 0.690 | 21 |
| Hotel Landis China Yangmingshan | 1.000 | 1 | 1.000 | 1 |
| Caesar Park Hotel Kenting | 0.972 | 8 | 1.000 | 1 |
| Howard Beach Resort Kenting | 0.754 | 18 | 0.667 | 22 |
| Hotel Royal Chihpen Spa | 0.885 | 11 | 0.792 | 16 |
| Grand Formosa Hotel, Taroko | 0.666 | 24 | 0.615 | 25 |
| Hotel Royal Chiao-his | 0.814 | 15 | 0.848 | 11 |
| Hotel Royal Hsinchu | 0.743 | 20 | 0.722 | 19 |
| The Ambassador Hotel Hsinchu | 0.703 | 21 | 0.846 | 12 |
| Tayih Landis Tainan | 0.688 | 23 | 0.660 | 23 |

Lake were ranked first in both years. The rankings of the Evergreen Plaza Hotel (Tainan), Hotel Kingdom, and the Farglory Hotel, Hualien improved significantly. The rank of the Hotel National dropped substantially. The Hibiscus Resort was ranked last in both years.

## Wilcoxon signed-rank testing

This paper also utilized Wilcoxon signed-rank testing to determine the average level of PTE (TE with the influence of SE removed) over two years ( $\overline{PTE}$ ), or whether the various hotels exhibited improvement trends. Therefore, $H_0$ and $H_1$ were described as follows (Table 7):

$H_0$: $\overline{PTE}_{2007} \leq \overline{PTE}_{2006}$

$H_1$: $\overline{PTE}_{2007} > \overline{PTE}_{2006}$

**Table 6**. Pure technical efficiency and rankings of independently-operated hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | PTE | Rank | PTE | Rank |
| The Grand Hotel | 0.846 | 13 | 0.898 | 12 |
| Imperial Hotel Taipei | 0.703 | 26 | 0.699 | 28 |
| Emperor Hotel | 1.000 | 1 | 1.000 | 1 |
| Hotel Riverview Taipei | 0.914 | 9 | 0.981 | 8 |
| Golden China Hotel | 0.840 | 15 | 0.857 | 14 |
| San Want Hotel | 1.000 | 1 | 1.000 | 1 |
| Brother Hotel | 0.890 | 11 | 0.930 | 9 |
| Santos Hotel | 0.838 | 16 | 0.826 | 16 |
| United Hotel | 0.949 | 7 | 0.993 | 6 |
| Hotel Kingdom | 0.751 | 22 | 0.836 | 15 |
| Hotel Holiday Garden Kaohsiung | 0.845 | 14 | 0.809 | 20 |
| Grand Hi-Lai Hotel | 1.000 | 1 | 1.000 | 1 |
| Han-Hsien International Hotel | 0.686 | 28 | 0.729 | 26 |
| Royal Lees Hotel | 0.781 | 19 | 0.814 | 17 |
| Hotel National | 0.858 | 12 | 0.748 | 24 |
| Plaza International Hotel | 0.825 | 18 | 0.810 | 19 |
| Evergreen Laurel Hotel (Taichung) | 1.000 | 1 | 0.982 | 7 |
| Astar Hotel | 1.000 | 1 | 1.000 | 1 |
| Marshal Hotel | 0.755 | 21 | 0.754 | 22 |
| Parkview Hotel | 0.723 | 23 | 0.753 | 23 |
| Farglory Hotel, Hualien | 0.777 | 20 | 0.874 | 13 |
| The Lalu Sun Moon Lake | 1.000 | 1 | 1.000 | 1 |
| The Hibiscus Resort | 0.641 | 29 | 0.630 | 29 |
| The Grand Hotel Kaohsiung | 0.903 | 10 | 0.903 | 11 |
| Taoyuan Hotel | 0.915 | 8 | 0.919 | 10 |
| Ta Shee Resort Hotel | 0.704 | 25 | 0.722 | 27 |
| Hotel Tainan | 0.827 | 17 | 0.804 | 21 |
| Evergreen Plaza Hotel (Tainan) | 0.694 | 27 | 0.811 | 18 |
| Formosa Naruwan Hotel and Resort Taitung | 0.712 | 24 | 0.731 | 25 |

**Table 7.** Wilcoxon testing for the $\overline{PTE}$ of various hotels.

| Variable | Chain hotels | Independent hotels |
|---|---|---|
| Z test (Wilcoxon score) | -1.043 | -1.947* |
| P-value | 0.1485 | 0.026 |

*indicates test results at the significance level of α = 5%.

In terms of the α = 5% significance level, it can be seen that $H_0$ is rejected based on changes in the average overall efficiency of independently-operated hotels, indicating that there was a trend of improvement. However, $H_0$ was accepted for chain hotels, indicating that $\overline{PTE}$ did not exhibit a trend of improvement.

## Scale efficiency analysis

### *Chain hotels*

It can be seen from Table 8 that the scale efficiency of the Caesar Park Hotel Taipei, Grand Hyatt Taipei, Grand Formosa Regent Taipei, and The Sherwood Hotel Taipei was equal to 1 in both years, indicating fixed returns to

**Table 8.** Scale efficiency and returns to scale for chain hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | SE | RTS | SE | RTS |
| The Ambassador Hotel | 0.992 | IRS | 0.992 | IRS |
| Gloria Prince Hotel | 1.000 | CRS | 0.992 | IRS |
| Caesar Park Hotel Taipei | 1.000 | CRS | 1.000 | CRS |
| The Landis Taipei Hotel | 0.955 | IRS | 0.956 | IRS |
| Sheraton Taipei Hotel | 0.999 | DRS | 0.998 | IRS |
| Hotel Royal Taipei | 0.928 | IRS | 0.936 | IRS |
| Howard Plaza Hotel | 0.983 | DRS | 0.987 | DRS |
| Grand Hyatt Taipei | 1.000 | CRS | 1.000 | CRS |
| Grand Formosa Regent Taipei | 1.000 | CRS | 1.000 | CRS |
| The Sherwood Hotel Taipei | 1.000 | CRS | 1.000 | CRS |
| Far Eastern Plaza Hotel (Taipei) | 0.957 | DRS | 1.000 | CRS |
| The Westin Taipei | 1.000 | CRS | 0.955 | IRS |
| The Ambassador Hotel Kaohsiung | 0.943 | IRS | 0.955 | IRS |
| Howard Plaza Hotel Kaohsiung | 0.925 | IRS | 0.935 | IRS |
| The Splendor, Kaohsiung | 0.954 | IRS | 0.954 | IRS |
| Howard Plaza Hotel Taichung | 0.875 | IRS | 0.879 | IRS |
| The Splendor Hotel | 0.913 | IRS | 0.843 | IRS |
| Chinatrust Hotel (Hualien) | 0.774 | IRS | 0.868 | IRS |
| Hotel Landis China Yangmingshan | 0.749 | IRS | 0.786 | IRS |
| Caesar Park Hotel Kenting | 0.907 | IRS | 1.000 | CRS |
| Howard Beach Resort Kenting | 0.913 | IRS | 0.955 | IRS |
| Hotel Royal Chihpen Spa | 0.877 | IRS | 0.934 | IRS |
| Grand Formosa Hotel, Taroko | 0.808 | IRS | 0.823 | IRS |
| Hotel Royal Chiao-hsi | 0.925 | IRS | 0.926 | IRS |
| Hotel Royal Hsinchu | 0.888 | IRS | 0.898 | IRS |
| The Ambassador Hotel Hsinchu | 0.919 | IRS | 0.950 | IRS |
| Tayih Landis Tainan | 0.950 | IRS | 0.951 | IRS |

scale. Only the Caesar Park Hotel Kenting experienced a movement from increasing returns to scale (IRS) to 1; the Far Eastern Plaza Hotel (Taipei) experienced an improvement from decreasing returns to scale to 1. In addition, the scale efficiency of the Howard Plaza Hotel was characterized by decreasing returns to scale in both years. The Gloria Prince Hotel and The Westin Taipei adjusted from fixed returns to scale to decreasing returns to scale (SE$<$1).

### *Independently-operated hotels*

It can be seen from Table 9 that only The Lalu Sun Moon Lake had a scale efficiency of 1 in both years, indicating fixed returns to scale. Only the Astar Hotel experienced a movement from increasing returns to scale to 1. In addition, The Grand Hotel, San Want Hotel, Brother Hotel, Grand Hi-Lai Hotel, and the Farglory Hotel, Hualien were characterized by decreasing returns to scale in both years. The Evergreen Laurel Hotel (Taichung) regressed from fixed returns to scale to decreasing returns to scale (SE$<$1).

### Wilcoxon signed-rank test

This study also utilized Wilcoxon signed-rank testing to determine the average level of SE in both years ($\overline{SE}$) and whether the different hotel categories exhibited trends of improvement. Therefore, $H_0$ and $H_1$ were explained as follows (Table 10):

$H_0$: $\overline{SE}_{2007} \leq \overline{SE}_{2006}$

$H_1$: $\overline{SE}_{2007} > \overline{SE}_{2006}$

In terms of level of significance α = 1%, $H_0$ was rejected for both chain hotels and independently-operated hotels.

Therefore, $\overline{SE}$ exhibited a significant trend of improvement.

**Table 9.** Scale efficiency and returns to scale for independently-operated hotels.

| DMU | 2006 | | 2007 | |
|---|---|---|---|---|
| | SE | RTS | SE | RTS |
| The Grand Hotel | 0.851 | DRS | 0.892 | DRS |
| Imperial Hotel Taipei | 0.980 | IRS | 0.993 | IRS |
| Emperor Hotel | 0.710 | IRS | 0.718 | IRS |
| Hotel Riverview Taipei | 0.925 | IRS | 0.938 | IRS |
| Golden China Hotel | 0.958 | IRS | 0.967 | IRS |
| San Want Hotel | 0.773 | DRS | 0.844 | DRS |
| Brother Hotel | 0.817 | DRS | 0.834 | DRS |
| Santos Hotel | 0.972 | IRS | 0.976 | IRS |
| United Hotel | 0.946 | IRS | 0.955 | IRS |
| Hotel Kingdom | 0.944 | IRS | 0.957 | IRS |
| Hotel Holiday Garden Kaohsiung | 0.916 | IRS | 0.924 | IRS |
| Grand Hi-Lai Hotel | 0.829 | DRS | 0.942 | DRS |
| Han-Hsien International Hotel | 0.995 | IRS | 0.998 | IRS |
| Royal Lees Hotel | 0.953 | IRS | 0.970 | IRS |
| Hotel National | 0.974 | IRS | 0.986 | IRS |
| Plaza International Hotel | 0.974 | IRS | 0.965 | IRS |
| Evergreen Laurel Hotel (Taichung) | 1.000 | CRS | 0.987 | DRS |
| Astar Hotel | 0.631 | IRS | 1.000 | CRS |
| Marshal Hotel | 0.941 | IRS | 0.940 | IRS |
| Parkview Hotel | 0.987 | IRS | 0.986 | IRS |
| Farglory Hotel, Hualien | 0.994 | DRS | 0.961 | DRS |
| The Lalu Sun Moon Lake | 1.000 | CRS | 1.000 | CRS |
| The Hibiscus Resort | 0.888 | IRS | 0.885 | IRS |
| The Grand Hotel Kaohsiung | 0.619 | IRS | 0.635 | IRS |
| Taoyuan Hotel | 0.957 | IRS | 0.959 | IRS |
| Ta Shee Resort Hotel | 0.939 | IRS | 0.940 | IRS |
| Hotel Tainan | 0.969 | IRS | 0.967 | IRS |
| Evergreen Plaza Hotel (Tainan) | 0.947 | IRS | 0.964 | IRS |
| Formosa Naruwan Hotel and Resort Taitung | 0.966 | IRS | 0.971 | IRS |

## Analysis of the influence of environmental variables on efficiency

This study utilized efficiency scores obtained using first-order DEA as a dependent variable (explained variable) and, taking into account the operating characteristics of domestic hotels and the methodology of other literature related to hotels, selected operating form, locality, scale, target customer segment, and guest nationality as independent variables (explanatory variables) to perform Tobit regression analysis. The analysis was conducted allowing for the assessment of whether explanatory variables such as the hotel operating form significantly influence the improvement of operating efficiency and to determine the influence direction of environmental variables on efficiency. The results are shown in Table 11.It can be seen from Table 11 that the hotel operating form and guest nationality have a significant positive impact on the average TE at the 1% level of significance; while locality and target customer segment have a significant negative impact on TE at the 5% level of significance; scale was not a significant factor.

In summary, joining a chain system can help to introduce management techniques and talent from foreign hotels, increasing the hotel operating efficiency. In addition, due to the slowing of growth among domestic and foreign travelers, the introduction of new sources of customers facilitates the improvement of hotel operating efficiency. From the perspective of locality, hotels in the Taipei region enjoy the highest occupancy ratios due to convenience and quality guarantees. In addition, due to the impact of the sub-prime mortgage crisis in the United States and increases in gasoline prices, growth has slowed in the number of foreign tourists visiting Taiwan.

**Table 10.** Wilcoxon test for the $\overline{SE}$ of different categories of hotels.

| Variable | Chain hotels | Independent hotels |
|---|---|---|
| Z testing (Wilcoxon score) | -2.418** | -3.030** |
| P-value | 0.008 | 0.001 |

**indicates test results at the 1 % levels of significance.

**Table 11.** Tobit regression estimation results.

| Variable | Coefficient | z-Statistic | Prob. |
|---|---|---|---|
| Constant | 0.766759 | 10.52331 | 0.0000 |
| Hotel operating form | 0.098656 | 3.298892 | 0.0010** |
| Locality | -0.019371 | -2.024408 | 0.0429* |
| Scale | -0.012571 | -0.624963 | 0.5320 |
| Target customer segment | -0.108853 | -2.319585 | 0.0204* |
| Guest nationality | 0.124371 | 3.522774 | 0.0004** |

* and **respectively indicate test results at the α=5 % and 1 % levels of significance.

The proportion of foreign guests and businessmen staying in Taiwanese hotels has dropped slightly, impacting the hotel operating efficiency increases.

## Conclusions

This study used the DEA methodology to measure the relative efficiency of chain and independent hotels in 2006 and 2007. The Tobit regression method was used to examine whether environmental variables have a significant impact on increases in efficiency. The findings of this study will provide a reference for improving operating efficiency. The results are explained subsequently:

1. In terms of overall efficiency: Among the chain hotels, well-known hotels performed the best. These hotels include the Caesar Park Hotel Taipei, Grand Hyatt Taipei, Grand Formosa Regent Taipei, and The Sherwood Hotel Taipei, which ranked first in both years. Among the independently-operating hotels, The Lalu Sun Moon Lake and Evergreen Laurel Hotel (Taichung) were ranked in the top three both years.

The Wilcoxon signed-rank testing indicated that independently-operated hotels exhibited trends in improving overall efficiency, but chain hotels did not exhibit improvements.

2. Pure management efficiency: Among the chain hotels, the Caesar Park Hotel Taipei, Grand Hyatt Taipei, Grand Formosa Regent Taipei, and The Sherwood Hotel Taipei performed the best. Among the independently-operating hotels, the Emperor Hotel, San Want Hotel, Grand Hi-Lai Hotel, Astar Hotel, and The Lalu Sun Moon Lake ranked near the top in both years.

The Wilcoxon signed-rank testing indicated that independently-operated hotels exhibited improving trends, but chain hotels did not show signs of improvement.

3. Scale efficiency: The SE of the Caesar Park Hotel Taipei, Grand Hyatt Taipei, Grand Formosa Regent Taipei, and The Sherwood Hotel Taipei was 1 in both years, indicating that these hotels were experiencing constant returns to scale. Among the independently-operated hotels, only The Lalu Sun Moon Lake had an SE of 1 in both years, indicating constant returns to scale.

The Wilcoxon signed-rank testing indicated that chain hotels and independently-operated hotels exhibited improving trends.

4. Impact of environmental variables on efficiency: The hotel operating form and guest nationality had a significant positive impact on average overall efficiency.

The geographical location and target customer segment had a significant negative impact on overall efficiency.

Overall, in the face of a highly competitive operating environment, hotel operators should create multiple brands and operate using market segmentation strategies to satisfy the demand from domestic and international travelers. Hotel operators must pursue internationalization in order to prosper.

In addition, to gain the favor of consumers, tourist hotel operators should continue to strengthen the “software” and “hardware” of their hotels and cooperate with partners in other industries to introduce discount packages to stimulate returning customers, allowing them to strengthen existing market shares and develop new sources of customers, thereby maintaining operating performance.

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