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Cost Efficiency of International Tourist Hotels in Taiwan: A Data Envelopment Analysis Application

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This paper uses the data envelopment analysis approach to measure cost, allocative and overall technical efficiencies of international tourist hotels (ITHs) in Taiwan during 1997–2006. There are three outputs, three inputs, three input prices and four environmental variables in the empirical model. The cost inefficiency of these hotels is from overall technical inefficiency. International tourist hotels in Taiwan have an average efficiency of 57%. Chain systems, non-metropolitan areas and occupancy rate have significantly positive impacts on all efficiency scores of Taiwan's ITHs. The distance from the nearest international airport significantly worsens their efficiency scores.

Key words: Taiwan, data envelopment analysis, cost efficiency, international tourist hotel

Introduction

Taiwan has abundant and diverse natural and cultural resources, providing great opportunities for tourism development. Over the period 1996–2007, total tourist arrivals to Taiwan increased from 2,358,221 to 3,716,063 – or 1.58 times the number 12 years before. According to the long-run forecast in the *Tourism 2020 Vision* by the World Tourism Organization (UNWTO, 2008), the number of total international arrivals globally is expected to reach nearly 1.6 billion by 2020, with 1995 as the base year.

In order to achieve growth in international tourists, accommodation service is now a priority. An international tourist hotel is one of the important key success factors of the tourism industry. As it plays such an important role in the tourism industry, a good understanding of the characteristics of the hotel industry is useful, and the performance of the industry can serve as one of the leading indicators of the level of tourism development in a country.

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There are two purposes of this study. First, a benchmarking analysis based on data envelopment analysis (DEA) is provided to explore Taiwan's hotel industry to assist managers in understanding the operational management of these hotels. Second, the Tobit regression is used to evaluate whether and how environmental variables (i.e. metropolitan areas or resort areas, chain or independent-owned, distance between the nearest international airport, and occupancy rate) can affect a hotel's efficiency.

The paper is organized as follows. The next section gives a literature review on international tourist hotels' efficiency. The third section discusses the methodology and the data. The fourth section discusses of the empirical results and the final section concludes.

Literature Review

Despite frontier efficiency research studies showing up in other industries, such as the banking industry, there is relatively little analysis of hotel efficiency in the literature. The two principal methods to evaluate the frontier of a hotel industry are the DEA approach and the stochastic frontier approach (SFA). In the field of tourism, the DEA approach has been used to measure hotel performance over the last decade and was largely used in previous studies.

DEA has many desirable features (Charnes, Lewin, Cooper, & Seiford, 1994), which may explain why researchers are interested in using it to investigate the efficiency of converting multiple inputs into multiple outputs. DEA is also a theory-based, transparent and reproducible computational procedure. In comparison with the traditional approaches such as ratio analysis and regression analysis (Sherman, 1986), DEA has gained several more advantages. One major advantage is that DEA has emerged as the leading method for efficiency evaluation in terms of both the number of research papers published and the number of applications to real-world problems (Gattoufi, Oral, & Reisman, 2004; Seiford, 1997; Yang & Lu, 2006). Previous studies that used DEA to investigate the relative efficiency of the hotel industry are now described as follows.

Morey and Dittman (1995) used the DEA model to measure a general manager's performance of 54 owner-managed hotels in the USA. They found that managers are operating at 89% efficiency, which means that managers could reduce their input cost by 11% without decreasing their output when they operate at the efficient frontier. Anderson, Fok and Scott (2000) used DEA to compute the overall, allocative, technical, pure technical and scale efficiencies of 48 hotels in the USA. They found the mean overall efficiency of 42% reveals that the hotel industry is operating quite inefficiently. The major cause of such a low level of efficiency is derived from allocative inefficiencies.

Tsaur (2001) implemented DEA to evaluate the operating efficiency of 53 international tourist hotels in Taiwan during 1996–1998. The result shows the average operating efficiency score is 87.33%, which implies that the hotel industry in Taiwan is operating efficiently. Hwang and Chang (2003) used DEA and the Malmquist productivity index (Färe, Grosskopf, Lindgren, & Roos, 1992) to measure the managerial performance of 45 hotels in 1998 and the efficiency change of 45 hotels from 1996 to 1998. This study shows the average efficiency value in 1998 was 79.16%. Moreover, Yang and Lu (2006) adopted DEA to explore 56 Taiwan international tourist hotels' managerial performance in 2002. The finding indicates the mean technical efficiency was 84.80%, which can be decomposed into pure technical efficiency and scale efficiency with means 0.876 and 0.969, respectively, showing that the inefficiency primarily comes from scale inefficiency. Furthermore, this paper examines operating characteristics, including management type, location and closeness to CKS airport, and whether they can influence the performance of international tourist hotels (ITHs). However, statistical analysis reveals no significance in managerial efficiency due to these operating characteristics.

By contrast, there are few studies in the literature that used the stochastic frontier approach to measure hotel performance. Anderson, Fish, Xia and Michello (1999) investigated 48 hotels in various regions of the USA by the stochastic frontier approach. Their study shows the mean efficiency score is 89.4%. It indicates the lodging industry is a highly efficient and competitive market. Chen (2007) employs a stochastic cost frontier function to estimate 55 international tourist hotels' efficiency. His results reveal that hotels in Taiwan on average operate at 80% efficiency. In addition, the factor of operation type significantly affects hotel efficiency, whereby the efficiency of chain hotels is higher than that of independent hotels. Note that previous studies on international tourist hotels in Taiwan use only 3 years of data at most to evaluate the performance of this industry (e.g. Chen, 2007; Chiang, Tsai, & Wang, 2004). This study extends the time-span of data and focuses on cost-minimizing behavior of ITHs in Taiwan.

Methodology and Data

DEA Model

Data envelopment analysis uses linear programming methods to construct a frontier by the decision-making units (DMUs) in the same period and then measures the efficiencies of DMUs relative to the estimated frontier. The concept of a frontier production function, proposed by Farrell (1957), could account for multiple inputs. Ever since Charnes, Cooper and Rhodes (1978) offered a model assuming constant returns to scale (CRS), the DEA methodology has been widely applied to various fields (Seiford & Thrall, 1990).

We assume there are data on K inputs and M outputs for each of the N firms. For the ith firm, these are represented by the column vectors $\boldsymbol{x}_i$ and $\boldsymbol{y}_i$. The $K \times N$ input matrix $\boldsymbol{X}$ and the $M \times N$ output matrix $\boldsymbol{Y}$ represent the data for all N firms. The input-oriented CRS DEA model then solves the following linear programming problem for firm i in each year:

$$\begin{gathered} \min_{\theta,\lambda} \theta \\ s.t. \ -\boldsymbol{y}_i + \boldsymbol{Y}\boldsymbol{\lambda} \geq 0 \\ \theta \boldsymbol{x}_i - \boldsymbol{X}\boldsymbol{\lambda} \geq 0 \\ \boldsymbol{\lambda} \geq 0 \end{gathered} \tag{1}$$

where θ is scalar and $\boldsymbol{\lambda}$ is an $N \times 1$ vector of constants. The value of θ is used as the efficiency score for the ith firm that satisfies $0 \leq \theta \leq 1$. The value of unity indicates a point on the frontier and hence a technically efficient firm.

Banker, Charnes and Cooper (1984) suggest an extension of the CRS DEA model, which is known as the BCC model, to deal with the situations of variable returns to scale (VRS). As not all firms are operating at the optimal scale, they may decompose further the overall technical efficiency (*OTE*) into pure technical efficiency (*PTE*) times scale efficiency (*SE*). In the VRS model, there is one differentiation from CRS by adding the convexity constraint, $N1'\lambda$, to equation (1). Moreover, the relation among the *OTE*, *PTE* and

SE scores is:

$$OTE = PTE \times SE \tag{2}$$

If price information is available, such as cost minimization, then CRS DEA can measure allocative efficiency and technical efficiency. The cost minimization CRS DEA model solves the following linear programming problem for firm *i* in each year:

$$\begin{aligned} &\min_{\lambda,\, x_i^*} \boldsymbol{w}_i' \boldsymbol{x}_i^* \\ &s.t. \ -\boldsymbol{y}_i + \boldsymbol{Y\lambda} \geq 0, \\ &\boldsymbol{x}_i^* - \boldsymbol{X\lambda} \geq 0, \\ &\boldsymbol{\lambda} \geq 0 \end{aligned} \tag{3}$$

where $\boldsymbol{w}_i$ is a vector of input prices for the *i*th firm and $\boldsymbol{x}_i^*$ is the cost-minimizing vector of input quantities for the *i*th firm. The cost efficiency of DMU *i* may be obtained from:

$$CE_i = \boldsymbol{w}_i' \boldsymbol{x}_i^* / \boldsymbol{w}_i' \boldsymbol{x}_i. \tag{4}$$

The value of *CE* is between zero and one. A value of $CE = 1$ represents that the firm is the cost-efficient DMU. The CRS allocative efficiency (*AE*) can be obtained from $AE = CE/OTE$. Consequently, the relation among all the efficiency scores taken into account in this study can be expressed as:

$$CE = AE \times OTE = AE \times PTE \times SE \tag{5}$$

Tobit Analysis

Although the efficiency scores from solving linear programming problems for the DEA models represent the ability of management to convert inputs into outputs at the current scale of operation, it is possible that some differences in operating characteristics may affect ITHs' performance. Therefore, it is important for this study to determine which ITH characteristics have an influence on variations in managerial efficiency across ITHs. The Tobit regression analysis is employed to estimate the relationship between managerial efficiency scores and ITHs' operating characteristics unrelated to the inputs used in the VRS model.

In order to evaluate the variation of cost efficiency of ITHs in Taiwan, we include three outputs, inputs, and input prices in the performance model. The choice of inputs and outputs is based on previous studies, as shown in Table 1, and the attainable data in the annual *Operating Report of International Tourist Hotel in Taiwan* (Taiwan Tourism Bureau, various years). The definitions of these variables are as follows.

Output variables:

- Total revenues of food and beverages (y_1), including incomes from sale of food, snacks, alcohol, beverages in dining room, coffee room, banquet and night club (tips are not included), measured in units of thousand New Taiwan dollars (NT$).
- Total revenues of rooms (y_2), including incomes from lease of rooms (tips are not included), measured in units of thousand NT$.
- Other revenues (y_3), including incomes other than the two items mentioned above. They include operating revenues from lease of store spaces, laundry, swimming pool, ball courts, barber-shop, beauty salons and bookstores, measured in units of thousand NT$.

Inputs variables:

- Number of guest rooms (x_1), including the nymber of guest rooms that can be provided for rent by an international tourist hotel.

Table 1 Literature on the Hotel Frontier

Study	Method	Units	Inputs	Outputs	Price
Moery and Dittman (1995)	DEA	54 US hotels, 1993	Room-division expenditures for salaries, benefits and meals; other room-division expenditures; salaries and related expenses for property, operation and maintenance; non-salary expenses for property, operation and maintenance; salaries and related expenses for variable advertising and promotion; non-salary expenses for variable advertising and promotion; fixed marketing expenditures; payroll and related expenses for administrative and general; non-salary expenses for administrative and general	Total room revenue; level of satisfaction with the physical facilities; level of satisfaction with the services provided	

(*Continued*)

Table 1 Continued

Study	Method	Units	Inputs	Outputs	Price
Anderson et al. (1999)	SFA	48 US hotels, 1994	The number of full-time equivalent employees; the number of rooms; total food and beverage expenses; total gaming-related expenses; other expenses	Total revenue	Average employee annual wage; average price of a room; average price of F&B operations; average price of casino operations; average price of hotel operations; average price of other expenses
Anderson et al. (2000)	DEA	48 US hotels, 1994	The number of full-time equivalent employees; the number of rooms; total food and beverage expenses; total gaming-related expenses; total hotel expenses; other expenses	Total revenue	Average employee annual wage; average price of a room; average price of F&B operations; average price of casino operations; average price of hotel operations; average price of other expenses
Tsaur (2001)	DEA	53 Taiwan hotels, 1996–1998	Total operating expenses; number of employees; number of guest rooms; total floor space of the catering division; number of employees in room division; number of employees in catering division; catering cost	Total operating revenues; number of rooms occupied; average daily rate; average production value per employee in the catering division; total operating revenues of the room division; total operating revenues of the catering division	

Hwang and Chang (2003)	DEA	45 Taiwan hotels, 1994–1998	Number of full-time employees; guest rooms; total area of meal department; operating expenses	Room revenue; food and beverages revenue; other revenues	
Barros (2004)	DEA	43 Pousada, hotels, 2001	Full-time workers; cost of labor; rooms; surface area of the hotel; book value of property; operational costs; external costs.	Sales; number of guests; nights spent.	
Yang and Lu (2006)	DEA	56 Taiwan, hotels, 2002	Total operating expenses; number of employees; number of guest rooms; total area of catering division	Total operating revenues; average occupancy rate; average room rate; average production; value per employee in the catering division; average production value of catering division.	
Chen (2007)	SFA	55 Taiwan, hotels, 2002		Total revenue.	Price of labor; price of F&B; price of materials.

Accordingly, the unit of measurement is simply "rooms", without subsequent adjustment being made for size or quality.
- Number of employees (x_2), including total employees who are involved in the operation of international tourist hotels, including medium- and high-ranking executives, guest room and catering staff, cooks, maintenance crews and repairmen.
- Total floor space of catering division (x_3), including the total floor space used by the operational units of all hotels' catering facilities, measured in square feet.

Input prices:

- Average price of room operations (w_1), referring to the total operating expenses per room, measured in NT$ per room. We use the total revenue of a hotel divided by the number of rooms.
- Average employee annual wage (w_2), referring to the salary and related expenses per employee, measured in NT$ per individual.
- Average price of food and beverages (F&B) operations (w_3), referring to the catering department expenses per square meter of floor space, measured in NT$ per square meter.

As the actual value of average price of operations was not reported in the annual report, we use the total operating expenses per room as the average price of rooms operations. It is a limitation of the study.

Empirical Results and Discussion

Descriptive Statistics

Table 2 provides descriptive statistics for all variables in the model. The average values of total revenues of food and beverages (y_1) are NT$262.8 million, total room revenue (y_2) NT$218.1 million, and other revenues (y_3) NT$9.393 million during the 10-year period of 1997–2006. The empirical data show that

Table 2 Descriptive Statistics of Outputs, Inputs and Input Prices (1997–2006)

Variable	*N*	Units	Mean	SD
Outputs				
F&B revenue (y_1)	547	10^3 NT$	262,800	26,448
Room revenue (y_2)	547	10^3 NT$	218,100	19,873
Other revenues (y_3)	547	10^3 NT$	93,930	12,873
Inputs				
Rooms (x_1)	547	Number	314	160
Employees (x_2)	547	Number	347	243
Floor space of catering division (x_3)	547	Square feet	1,190	1,281
Input prices				
Price of room (w_1)	547	NT$	155,3701	856,131
Price of labor (w_2)	547	NT$	483,875	142,959
Price of F&B (w_3)	547	NT$	100,768	99,014

Note: All monetary units are at 1997 price level.

the average revenues of food and beverage were higher than those of rooms in the period 1997–2006. This finding is consistent with the finding by Tsaur (2001), because increasing ratios of people in Taiwan who eat out as local consumers in Taiwan are used to dining outside. Standard deviations of outputs are quite large, perhaps due to the fact of the very significantly different sizes of hotels. According to both the survey of *Global Views Monthly* (2007), one of the most famous magazines in Taiwan, and the report of The Chinese Federation of Dietitians' Association (2008), more than 70% of Taiwanese people eat out. Owing to the growth of the economy, Taiwanese people are now enjoying an increase in average income, rate of employment for women, as well as a better change in lifestyle. All contribute to an increase in people eating out, especially at ITHs' restaurants, subjected to growth of spending power and demand of service quality.

Table 3 shows the correlation matrix of inputs x_i and outputs y_i. The result reveals that all the correlation coefficients between input and output are positive, implying the isotonic property is satisfied in this study. It means that the variables included in the model are appropriate. Cooper et al. (2000) suggest that the number of ITHs should be at least triple the number of inputs and outputs considered. In this study the number of ITHs is 68, at least triple the selected nine factors for the DEA model. We hence conclude that the developed DEA model holds high construct validity. In addition, we use panel data covering observations on the outputs and inputs of 68 ITHs for 1997–2006 to measure managerial efficiency changes for those ITHs.

Operational Efficiency Analysis

This study adopts DEA to estimate the operational efficiency of international tourist hotels. The efficiency values include cost efficiency (*CE*), allocative efficiency (*AE*), technical efficiency (*TE*), pure technical efficiency (*PTE*) and scale efficiency (*SE*). The computed results are summarized in Table 4.

The average score of technical efficiency is slightly lower than the allocative efficiency every year. The combined effect of these two results is in the low average score of cost

Table 3 Correlation Matrix for Inputs and Output, 1997–2006

	Outputs			Inputs		
	y_1	y_2	y_3	x_1	x_2	x_3
y_1	1.0000					
y_2	0.8739	1.0000				
y_3	0.8451	0.8300	1.0000			
x_1	0.7412	0.7785	0.7107	1.0000		
x_2	0.9346	0.8313	0.8322	0.7946	1.0000	
x_3	0.6442	0.4991	0.6180	0.5387	0.6562	1.0000

Table 4 Mean Efficiency Scores of International Tourist Hotels (1997–2006)

Year	*CE*	*AE*	*TE*	*PTE*	*SE*
1997	0.564	0.778	0.707	0.795	0.880
1998	0.596	0.817	0.714	0.823	0.861
1999	0.576	0.798	0.707	0.823	0.853
2000	0.578	0.803	0.703	0.797	0.875
2001	0.576	0.775	0.722	0.828	0.867
2002	0.561	0.787	0.699	0.811	0.858
2003	0.576	0.756	0.743	0.820	0.901
2004	0.544	0.736	0.727	0.810	0.892
2005	0.569	0.764	0.739	0.820	0.894
2006	0.562	0.768	0.721	0.819	0.870
Average	0.570	0.778	0.718	0.815	0.875
Minimum	0.544	0.736	0.699	0.795	0.853
Maximum	0.596	0.817	0.743	0.828	0.901
SD	0.014	0.024	0.015	0.011	0.016

efficiency for all international tourist hotels during the period 1997–2006. The average cost efficiency score is 0.570, suggesting that hotels could reduce their input costs by 43% without decreasing their output. The result shows that inefficiency is coming from both allocative and technical inefficiencies, but more primarily due to technical inefficiency.

As we find that technical inefficiency is the primary factor of cost inefficiency, we should examine the effect of technical inefficiency by decomposing technical efficiency into pure technical efficiency (*PTE*) and scale efficiency (*SE*) every year. The results are listed in Table 4. We find that the average score of scale efficiency and the average score of pure technical efficiency are 0.875 and 0.815, respectively. The scores of pure technical efficiency are slightly lower than scale efficiency every year. This result reveals that the overall technical inefficiency is due in large part to pure technical inefficiencies. This implies that the number of ITHs is approaching market saturation and also suggests that managers should focus first on removing the pure technical inefficiency of ITHs, and then ITHs can be subject to improving their scale efficiencies.

With regards to pure technical efficiency, on average ITHs can produce the same level of measured output with 18.5% fewer inputs, holding the current input ratios constant. All of the ITHs need to reduce their inputs if they are to become efficient. This indicates overall that ITHs still have much room to improve their pure technical efficiencies.

The above findings suggest that managers should first focus on improving the technical inefficiency, especially on pure technical inefficiency, and then they can be subject to removing allocative inefficiency. The results are not very similar to those previous studies that found the market for international tourist hotels is operating efficiently in Taiwan.

Trends of Efficiency during 1997–2006

In order to understand the variations in the market of international tourist hotels over the years 1997–2006, we plot the trends of cost efficiency, allocative efficiency and overall technical efficiency in Figure 1.

As Figure 1 shows, the directions of allocative efficiency and overall technical efficiency are almost opposite. The effect of allocative efficiency is relatively large, resulting in cost efficiency following the trend of allocative efficiency. This implies that ITHs are facing a highly competitive environment in Taiwan. The total number of Taiwan's ITHs increased from 43 to 68 (58% growth rate) in the period 1989–2006, creating a situation of oversupply. As a result, too many ITHs competing for a limited number of foreign tourists made most ITHs operate at diseconomies of scale. With existing inputs as sunk costs or fixed costs to business operations, the ITHs are consequently facing greater competition. They should try to minimize their losses by serving tourists whenever they can so as to cover their variable costs.

There are two apparent fluctuations in 1998 and 2003. First, the increasing cost efficiency is due to the growth of domestic tourists. In Taiwan the largest percentage of total tourists at about 30–40% is domestic tourists every year. Starting in January 1998, the implementation of the 2-day weekend policy has resulted in people having more time for activities such as recreation and travel, especially domestic tourism. The changing consumption pattern and the quality of service have pushed the international tourist hotels to become the favorite choice of lodgings. This change of demand for tourist hotels is increasing. We find that the efficiencies of ITHs are much higher in 1998. In 2003, the SARS epidemic in Taiwan not only saw foreign tourists drop, but also domestic tourists. The total number of visitor arrivals in 2003 declined severely, by 24.5%. The low cost efficiency and allocative efficiency reflected the impact of the seriousness of this disease. However, technical efficiency rose in the period. As the scale efficiency is quite high, it shows that international tourist hotels are quite close to their optimal scales.

Results of Tobit Regression

In the second stage we use the Tobit censored regression model to assess the influence of various management factors on the efficiency scores of international tourist hotels throughout the research period. There are four

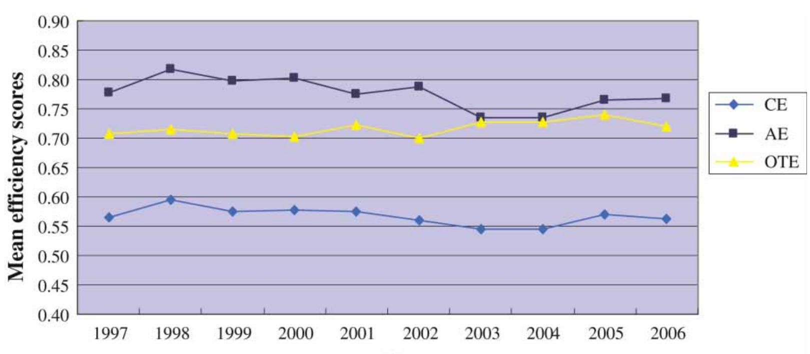

Figure 1 Trends of International Tourist Hotel Efficiency Scores in Taiwan (1997–2006).

environmental variables selected in this study: type of location (*LOC*; 1 = resort area, 0 = metropolitan area), type of operation (*OPE*; 1 = chain, 0 = independent), distance to nearest international airport (*DIS*) and the occupancy rate (*OR*). The cost efficiency scores, and allocative, overall technical, pure technical and scale efficiency scores are used as variables in each Tobit regression equation. The model can be illustrated as follows:

$$Efficiency_{it} = \beta_0 + \beta_1 LOC_{it} + \beta_2 OPE_{it} + \beta_3 DIS_{it} + \beta_4 OR_{it} + u_{it} \quad (6)$$

where β_0 is the constant term and u_{it} is the error term following a normal distribution. The coefficients of the environmental variables are our concern. The estimated results of Tobit regression are listed in Table 5.

The estimated coefficient of the type of location, β_1, is significantly positive for the cost, overall technical and pure technical efficiencies. This means that a hotel located in a resort area has significantly higher cost, and overall technical and pure technical efficiencies than that in a metropolitan area. In other words, Table 5 shows that ITHs located in resort areas operate slightly better on average than those located in metropolitan areas. Another dummy variable, the type of operation, shows a significantly positive influence on all kinds of efficiency discussed in this study. In other words, the type of operation being chain-operated could increase the efficiency of international tourist hotels.

The distance between the hotel and nearest international airport (e.g. Taoyuan International Airport and Kaohsiung International Airport) has significantly negative effects on cost and allocative efficiencies. The shorter the distance from the nearest international airport, the higher the cost and allocative efficiencies will be.

Table 5 Tobit Regression Results

Variable	*CE*	*AE*	*OTE*	*PTE*	*SE*
Constant	−0.03062	0.46894***	0.14270***	0.52050***	0.49425***
	(0.43680)	(<0.001)	(< 0.001)	(<0.001)	(<0.001)
LOC	0.06190***	0.02768	0.10783***	0.16669***	−0.00041
	(0.01000)	(0.14120)	(<0.001)	(<0.001)	(0.97900)
OPE	0.11068***	0.06892***	0.08892***	0.07703***	0.04319***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
DIS	−0.00038***	−0.00054***	−0.00001	0.00002	−0.00005
	(0.00360)	(<0.001)	(0.91210)	(0.86870)	(0.55400)
OR	0.00897***	0.00495***	0.00847***	0.00417***	0.00595***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
R^2	0.43533	0.30417	0.35600	0.15714	0.41299
Adjusted R^2	0.43011	0.29774	0.35005	0.14935	0.40757

Notes: Numbers in parentheses are the *p*-values.
***Significance at the 1% level.

The occupancy rate displays a significantly positive influence on all the efficiencies. This indicates that the higher the occupancy rate is of the hotel, the more efficient the hotel will be.

Concluding Remarks

While service industries have become increasingly important in the global economy in recent years, especially after the global economy's latest financial tsunami, the issue of international tourism industries is especially valuable for a small open economy such as Taiwan, because tourism has not only become one of the largest sources of income for Taiwan, but also has effective means to stimulate global economic development. Although the international tourism industry's efficiency has been widely discussed in the literature and the DEA technique is frequently used to explore this topic, there are still some important points that have not been touched on. This paper therefore has explored the cross-period efficiency (using 1997–2006 operating data) from a more complete viewpoint.

Cost efficiency affects the financial performance of international tourist hotels. This study has examined the variation of cost efficiency of international tourist hotels in Taiwan over the period 1997–2006. Besides overall technical efficiency, controlling operation costs is an important issue for hotel managers. For this purpose, we have used a more comprehensive DEA model incorporating three outputs, three inputs and three input prices to compute cost, allocative, technical, pure technical and scale efficiencies at the first stage.

The results indicate the average cost efficiency score is 0.570 in the research period, implying that managers could reduce their input costs by 43% if the firm operated on the efficient frontier. Although both technical inefficiency and allocative inefficiency are the cause of cost inefficiency, technical inefficiency is actually the more severe problem. By decomposing overall technical efficiency into pure technical and scale efficiency, we found that the core of inefficiency is due primarily to pure technical inefficiency. For a hotel manager, spending more effort on improving overall technical efficiency, especially the pure technical inefficiency, has more instantaneous results than allocation efficiency.

Our findings do not correspond with previous studies that found that the international tourist hotel market in Taiwan is operating at a high efficiency level. The major reason is because our model considers the input prices, which help catch more inefficiency. Furthermore, Tobit regression is employed to examine environmental variables' effect on hotels' efficiency. First, the cost efficiency of a hotel located in a resort area is higher than that located in a metropolitan area. Second, the cost efficiency of a chain hotel is higher than that of an independent hotel. Third, the closer a hotel is to the nearest international airport, the higher cost efficiency the hotel will have. Finally, the higher occupancy rate a hotel has, the higher its cost efficiency will be.

In future research, we can use a stochastic frontier approach to compare the findings between different methods. Adding qualitative inputs and outputs in the model, such as quality of services, customer satisfaction and quality of employees, will help to obtain more complete results.

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