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An Analysis of the Operational and Management Efficiency of Five-Star Hotels in Taiwan

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Abstract

In this study, data envelopment analysis and the Malmquist Index were applied to examine the operational efficiency and management efficiency of five-star hotels in Taiwan during the 2006–2011 period. Initially, a data envelopment analysis model was adopted to conduct a cross-section analysis of the management performance of each five-star hotel in Taiwan. Following this, the Malmquist Index was used to assess the total factor productivity and longitudinal cross-period development. Then, a management matrix was formed to show the corresponding positions of the decision-making units. The provided management information clearly presented the competitiveness status of each five-star hotel. The empirical results of this paper offer practical suggestions on how to adjust the production scale to achieve optimal scale.

Keywords: data envelopment analysis, Malmquist index, five-star hotel, operational efficiency, management efficiency, management matrix

1. Introduction

Tourism is a localized and deeply rooted industry that will not relocate overseas. It serves as an indicator for the economic development of a country and every nation is sparing no effort to loosen visa application restrictions, obtain international flight routes, and implement sales tax return for foreign visitors to stimulate tourism. In Taiwan, the government has also begun to value the tourism industry more and more by taking various measures to encourage the development of businesses related to tourism and this has resulted in an increase in demand for accommodation. Statistics from the Tourism Bureau indicate that the number of foreign visitors to Taiwan grew from 2.29 million visits in 1998 to 6,087,484 visits in 2012, an increase of 164.62%. Meanwhile, the total amount spent on lodging at international hotels also escalated from NT$148 million to NT$19.14 billion. As a consequence, the number of international hotels increased from 40 in 1992 to 70 at the end of 2012. The number of rooms available grew by 56.62%, increasing from 13,000 to 20,361. From these figures it can be inferred that due to the increase in supply and the demand in the international hotel market, hotels are finding itself facing tougher competition. Under such circumstances, how to maintain profit in the fiercely competitive market becomes an important issue. Each hotel has to learn how to improve the operational efficiency; however, “productivity” is another important indicator in assessing the management condition of each hotel. Productivity changes can be identified by evaluating whether a hotel has made progress during the period of observation. Based on this, it is possible to determine whether such a hotel has the potential to grow.

In the past, data envelopment analysis (DEA) has been applied in many studies on the operational efficiency of international hotels (Morey & Dittman, 1995; Brown & Ragsdale, 2002; Sanjee, 2007; Lee & Wang, 2012). To assess cross-period operational efficiency, Barros (2005a; 2005b) used DEA and the Malmquist Index (MI) and Tobit regression to analyze the operational efficiency of 42 public hotels operated under the Enatur system. Hwang and Chang (2003) adopted a DEA model to measure the management performance of 45 international hotels in Taiwan in 1998 and then assessed the changes in hotel efficiency from 1994 to 1998 with the MI. Meanwhile, Lee and Wang (2012) employed a decomposition method to break down the Malmquist TFP Indexes, in descending order, into technical changes, pure technical efficiency changes, scale efficiency changes, and output mix changes to study the productivity changes of 58 international hotels in Taiwan between 2002 and 2008. However, in all the aforementioned literature, the hotels were never classified for performance evaluation with DEA. Apparently, the samples lacked precision. In addition, how the input items were distributed in the production of different output items, the internal production process, in other words, was neglected and this could limit the results of measurement and analysis. For this reason, in this paper the two-stage DEA applied by Seiford and Zhu (1999) was used to analyze the operational efficiency and management efficiency of 25 five-star hotels in Taiwan to overcome the lack of management information encountered when one-stage DEA is applied. Hence, the objectives of this study are as follows:

i. Using the CCR and BCC models to assess the operational efficiency of the five-star hotels in Taiwan during the 2005–2012 period and forming suggestions for each company on how to adjust its input items to achieve optimal scale efficiency;

ii. Using the two-stage MI to assess and compare the cross-period operational efficiency of five-star hotels and overcome the problem of a number of efficiency values being 1 and therefore undistinguishable while at the same time separate the high-efficiency leading group from the low-efficiency lagging group and examine them respectively.

This paper is a study on the performance of 25 five-star hotels in Taiwan between 2006 and 2011. The structure is as follows: Section 2 is devoted to literature review; Section 3 describes the study design; Section 4 presents the empirical results; and Section 5 is the conclusion and suggestions.

2. Literature Review

According to the Taiwan Tourism Bureau, hotels are divided into two kinds, namely international hotels and regular hotels. The former are rated as five- or four-star hotels and the latter three- or two-star hotels. According to the type of ownership (management), international hotels are categorized into those under independent management and the ones under (international and local) chain management. The latter include three types: franchise chain, management contract chain, and conferral chain (Hwang & Chang, 2003). Currently, the chain-affiliated international hotels in Taiwan include Sheraton Grande Taipei Hotel operated under Sheraton Group; Hotel Royal Taipei and Hotel National Taichung under the Nikko management system; Grand Hyatt Taipei under Hyatt Hotels Corporation; Shangri-La's Far Eastern Plaza Hotel under Shangri-La Group; Landis Hotels & Resorts and the Sherwood Taipei both being members of the Leading Hotels of the World reservation system, with the Taipei Sherwood being also part of Preferred Hotel Group; the Westin Taipei a member of Westin Hotels and Resorts; Imperial Hotel Taipei part of the Prince Hotel Chain; and the Lalu Hotel an affiliate to General Hotel Management Group (GHM). These hotels have brought in hotel management techniques and talents from Europe and North American. In the mean time, the Tourism Bureau also established a hotel star rating system in 2009 to speed up the improvement of international hotel management and service quality. The Taiwan Assessment and Evaluation Association has been delegated to conduct the rating. So far, most related literature has been focused on the levels and differences of operational efficiency of chain hotels and independent hotels (Hwang & Chang, 2003; Wang, Hung, & Shang, 2006; Chiang, Tsai, & Wang, 2004). Nevertheless, what hotels are facing is a highly competitive market, especially five-star hotels that are dedicated to serving customers of higher socio-economic demographics. How to maintain the profit in the fiercely competitive market has thus become an important issue. Each international hotel needs to know how to upgrade its operational efficiency and "productivity" in order to increase its competitiveness.

Berger, Hunter and Timme (1993) suggested using DEA models as indicators in performance measurement because they could process multiple output and input items and maintain units invariance while the weight would not be affected by subjective factors. Morey and Dittman (1995) discovered that 34 of the 54 owner-managed hotels that were affiliated to internationally renowned chains had no efficiency (the efficiency value smaller than 1) and their average total efficiency was merely 0.89. Barros (2005a; 2005b) applied DEA, the MI and Tobit regression to conduct operational efficiency analysis on 42 public hotels belonging to the Enatur hotel system between 1999 and 2001 and the results indicated that X-efficiency clearly existed as a consequence of the location, clustering effect and organizational factors, meaning that the scale of a hotel could have a significant effect on efficiency and, at the same time, delays in time had led to lagging in technology because employees in public enterprises received less encouragement and these hotels were unable to achieve scale efficiency. Barros believed that, besides expanding the scale and reducing the number of employees, management improvement was the most effective approach to ameliorate the operational efficiency of these hotels once and for all. Brown and Ragsdale (2002) used DEA and a service quality scale to examine the service quality and operational efficiency of hotels. It was discovered that the number of rooms (scale) was one of the factors influencing service quality and operational efficiency. Sanjeev (2007) adopted financial indices to analyze the efficiency of 68 hotels in India and found that 18 of them were efficient; the average efficiency of the samples was 0.73, meaning that scale did not have a significant effect.

Hwang and Chang (2003) adopted a DEA model to measure the management performance of 45 international hotels in Taiwan in 1998 and used the MI to assess the efficiency changes in these hotels between 1994 and 1998. The results showed that the difference in the performance of these hotels was significantly related to whether the guests were foreigners and the management style of the hotel (independent or affiliated to an international chain). Wang et al. (2006) conducted a study on the operational efficiency of international hotels in Taiwan and discovered that the average efficiency was 0.81, failing to achieve the relative operational efficiency standard and indicating that the hotels could reduce 19% of their personnel, number of rooms or the floor area of their food and beverage departments to make improvements. The results obtained through Tobit regression showed that those targeting the business hotel market faced tougher competition whereas the ones affiliated to hotel chains (as opposed to those independently managed) had better efficiency and scale had no significant influence. Assaf, Barros and Josiassen (2010) used auto-random sampling metafrontier DEA to analyze the management performance of 78 hotels in Taiwan between 2004 and 208 and the results revealed that scale (300 employees as the borderline), ownership (chain or independent), and hotel type (international or regular) all had a significant effect on efficiency. Hu, Chiu, Shieh and Huang (2010) applied one-stage SFA to estimate the cost efficiency of 66 international hotels in Taiwan between 1996 and 2006 and the results were that the average efficiency was 91.15% and whether they were chain members, the number of tour guides they dealt with, and their distance to the international airport were factors that had a significant effect on cost efficiency. Lee and Wang (2012) employed an ascending decomposition method to break the Malmquist TFP down into technical changes, pure technical efficiency changes, scale efficiency changes, and output mix changes to examine the productivity changes of 58 hotels in Taiwan between 2002 and 2008. The empirical results indicated that the total factor productivity grew by 1.56% on average during the study period, the driving force mainly stemming from technical progress (1.43%), and the pure technical efficiency also went up by 0.2%. As for the scale efficiency and output mix changes, the overall index stayed relatively stable around 1. The operational performance management matrix showed that over 35% of these international hotels were currently competitive and had the potential for long-term development.

In most of the aforementioned literature, the MI was applied to analyze the cross-period operational efficiency of international hotels. How the input items were distributed to produce different output items remained unspecified. The internal production process was neglected and this could limit the results of measurement and analysis. Hence, Yang and Lee (2013) and Lin, Yen and Yang (2012) adopted multi-stage DEA to analyze operational efficiency to reflect management information in the production process while at the same time used a management matrix in a 2D diagram to classify the leading and lagging groups to analyze the competitive advantages and disadvantages in different stages.

3. Research Design

The study is divided into four parts, namely sources of data and definition of variables; the two-stage DEA framework; the CCR and BCC models; and the MI. In the following, each of them is described.

3.1 Sources of Data and Definition of Variables

The data applied in this paper have been taken from the Analytic Report of the Management of International Hotels in Taiwan published by the Tourism Bureau. The report was intended to help hotel operators, investors, and academic and research units to understand the management condition of international hotels in Taiwan. Those rated by the Tourism Bureau as five-star hotels have been selected to be the samples. They must have been established before 2006; otherwise, the samples are deleted. Moreover, the ones lacking complete data in the said report are also removed. In the end, only 25 five-star hotels remain valid samples. They are the Grand Hotel (1), the Ambassador Hotel (2), Imperial Hotel Taipei (3), Landis Hotels & Resorts (4), Sheraton Grande Taipei Hotel (5), Howard Hotels Resorts Suites (6), Grand Hyatt Taipei (7), Grand Formosa Regent (8), the Sherwood Taipei (9), Shangri-La's Far Eastern Plaza Hotel (10), the Westin Taipei (11), Miramar Garden Taipei (12), the Ambassador Hotel Kaohsiung (13), the Grand Hi Lai Hotel (14), 85 Sky Tower Hotel (15), Evergreen Laurel Hotel Taichung (16), Farglory Hotel (17), Hotel Royal Chiao His (18), the Lalu Hotel (19), Caesar Park Hotel & Resorts (20), Howard Beach Resort Kenting (21), Ambassador Hotel Hsinchu (22), Tayih Landis Hotel (23), Evergreen Plaza Hotel Tainan (24), and Formosan Naruwan Hotel & Resort (25).

3.2 The Two-Stage DEA Framework

Due to the accessibility of data and characteristics of international hotels in Taiwan, input and output variables adopted in past literature are selected for this paper. Reference has also been made to the management information presented in the production process with two-stage DEA by Saiford and Zhu (1999) and the number of rooms, the floor area of the food and beverage department, and operating expenses are applied as the input items and the room revenue and the food and beverage revenue as the output items to assess the operational efficiency in the first stage. In the second stage, the output items in the first stage are defined as the input items (room revenue and food and beverage revenue) while the average output value per employee and the occupancy rate are regarded the output items to measure management efficiency (Hwang & Chang, 2003; Chen, Lu, & Chung, 2010; Sun & Lu, 2005), as shown in Figure 1.

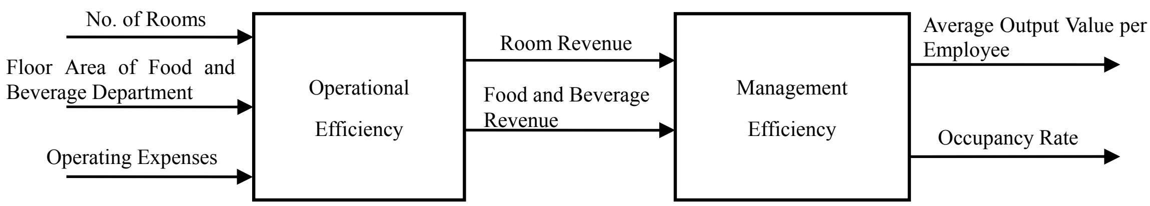

Figure 1. Two-stage DEA framework

In DEA, the input and output items and the decision-making units (DMUs) have to be maintained at a certain relationship to give validity to the analytic results of the DEA model. With each input item increased, the discriminating power of DEA has to be reduced. However, since increasing the number of decision-making units will also boost the discriminating power, the number of decision-making units therefore must be at least twice the aggregate of the input and output items (Bowlin, 1987; Golany & Roll, 1989). In this study, three input items and two output items are selected in the first stage and two input items and two output items in the second stage. The study variables are as shown in Table 1. The number of decision-making units is 25. Hence, all of them comply with the suggestions put forth in the aforementioned literature.

Table 1. Definition of input and output items

Name of Variable	**Description**	**Unit**
No. of Rooms	The total number of rooms built in the international hotel	Room
Floor Area of Food And Beverage Department	The total number of ping of the floor area of the food and beverage department, not including kitchens	Ping
Operating Expenses	The principal service and material expenses, not including personnel costs	NT dollar
Room Revenue	Income from guest accommodation	NT dollar
Food and Beverage Revenue	Income from sales of food and beverages in the restaurants, banquet halls and night clubs in the hotel, but not including service charge	NT dollar
Average Output Value per Employee	Total revenue/no. of employees	NT dollar
Occupancy Rate	No. of rooms occupied/total no. of rooms	%

Since the relative efficiency value calculated with DEA is obtained through computation of the input and output items of each decision-making unit, the input and output items and the number of decision-making units have to be maintained at a certain relationship in order to give validity to the analytic results of the DEA model. Therefore, the input and output items in this study are selected in accordance with the following procedure. Initially, tests are run to decide whether there is isotonicity between the input and output items. In other words, increase of a certain input item should not lead to decrease of a certain output item (Huang, 1993), so that the basic requirement for the relationship between input and output is met and assessment with DEA can have validity. In this research, the Pearson correlation coefficient is adopted to examine the appropriateness of the input and output variables. Tables 2 and 3 show the results of analysis of the input and output items which prove that a positive correlation exists between the variables. Hence, the input and output items in this study meet the isotonicity requirement.

Table 2. The correlation coefficient of first stage

	RE	FBR	NR	AFBD	OE
RE	1				
FBR	0.8399	1			
NR	0.8344	0.7520	1		
AFBD	0.6509	0.4414	0.7076	1	
OE	0.7683	0.8010	0.6503	0.3883	1

Note. Room Revenue(RE); Food and Beverage Revenue(FBR); No. of Rooms(NR); Floor Area of Food and Beverage Department(AFBD); Operating Expenses(OE).

Table 3. The correlation coefficient of second stage

	AOVE	OR	RE	FBR
AOVE	1			
OR	0.2909	1		
RE	0.7788	0.126	1	
FBR	0.8049	0.1248	0.8399	1

Note. Average Output Value Per Employee(AOVE); Occupancy Rate(OR); Room Revenue(RE); Food and Beverage Revenue(FBR).

3.3 The CCR and BCC Models

DEA was developed by Charnes, Cooper and Rhodes (1978) according to "the measurement of productive efficiency" put forward by Farrell (1957). The DEA is also sometimes called Constant Returns to Scale (CRS) because the CCR model entails the hypothesis that the returns to scale are constant. Banker, Charnes and Cooper (1984) expanded the concept and range of application of CCR and adjusted the CRS hypothesis to become the hypothesis of various returns to scale (VRS). Since the production process can be one of increasing returns to scale (IRS) or decreasing returns to scale (DRS), especially when the inefficiency of an inefficient decision-making unit is a result of management under various returns to scale, it is possible to provide managers with more information for improvement of efficiency after understanding the status of returns to scale of each decision-making unit. Banker et al. (1984) again divided technical efficiency into pure technical efficiency (PTE) and scale efficiency (SE) to explore issues associated with technical efficiency, scale efficiency, and returns to scale. This is the so-called BCC model. Technical efficiency (TE) = PTE x SE. When SE is 1, the DMU is under CRS. If it is smaller than 1, then the DMU is probably under IRS or DRS.

3.4 Malmquist Index Model

Since the CCR and BCC DEA models can only be applied in static assessment of each DMU in a single fiscal year, this study therefore adopts the modified MI proposed by Färe, Grosskopf, Norris and Zhang (1994) to improve the study approaches of Caves, Christensen and Diewert (1982) in order to evaluate the cross-period dynamic relations between productivity changes, technical changes, efficiency changes, pure technical efficiency changes, and scale efficiency changes as well as to measure the cross-period total factor productivity change (TFPCH). The modified model of Färe et al. (1994) is presented with geometric means to prevent errors in the outcome as a result of the difference in selection of the t period. The assessment model is as shown in Equation (1):

$$TFPCH \ \left\langle x^{t+1}, y^{t+1}, x^{t}, y^{t} \,\middle|\, CRS \right\rangle = \left[\frac{D_0^{t}\left\langle X^{t+1}, y^{t+1} \,\middle|\, CRS \right\rangle D_0^{t+1}\left\langle X^{t+1}, y^{t+1} \,\middle|\, CRS \right\rangle}{D_0^{t}\left\langle X^{t}, y^{t} \,\middle|\, CRS \right\rangle D_0^{t+1}\left\langle X^{t}, y^{t} \,\middle|\, CRS \right\rangle} \right]^{1/2} \quad (1)$$

The focus of this study is set on the right quantity of input to achieve maximum efficiency under the current output standard. The BCC input orientation is adopted as the model in this study to assess the operational efficiency of each DMU, examine its annual changes, and identify the factor that has key influence on productivity. The relationship is: the total factor productivity change (TEPCH) = total efficiency change (TE) x production technical change (PCH) and TE = PTE x SE. When TEPCH is larger than 1, it means the DMU has made progress during the period when it is assessed. When TEPCH is smaller than 1, it means the DMU has become less efficient during the period when it is assessed. When SE is larger than 1, it means the DMU is has gradually moved closer the long-term optimal production scale or constant returns to scale. When SE is smaller than 1, it means the DMU has gradually deviated from the long-term optimal production scale or constant returns to scale. When SE equals 1, it means the DMU has experienced no changes during this period.

4. Empirical Results and Analysis

The DEAP version 2.1 software designed by Coelli (1996) is adopted in this study to evaluate and analyze the management performance of international hotels. First, the CCR and BCC models are used to conduct cross-section analysis of the hotels to obtain the efficiency values of the first stage and second stage and analyze the scale condition. Then, the MI is applied to measure cross-period productivity changes. Lastly, the management matrix composed of the MI efficiency values obtained in the first and second stages is presented to provide management information.

4.1 DEA Cross-section Empirical Results

Table 4 shows that, the operational efficiency in the first stage, in the aspect of returns to scale, Grand Formosa Regent, Hotel Royal Chiao Hsi, and the Lalu Hotel maintained their scale efficiency at 1 throughout the 2006-2011 period, indicating that their production scale was in the most appropriate condition. The operational efficiency of Grand Hotel, Imperial Hotel Taipei, Landis Hotels and Resorts, Miramar Garden Taipei, the Ambassador Hotel Kaohsiung, the Grand Hi Lai Hotel, 85 Sky Tower Hotel, Evergreen Laurel Hotel Taichung, the Ambassador Hotel Hsinchu, Tayih Landis Hotel, and Evergreen Plaza Hotel Tainan was under IRS, indicating that their business scales were too small and would have to increase the scale to achieve optimal condition. Meanwhile, Howard Hotels Resorts Suites and Grand Hyatt Taipei were operating under DRS, meaning their business scales were too large and they had to reduce input items to prevent waste of company resources.

Table 4. Operational efficiency in the first stage

Firm	2008				2009				2010				2011			
	TE	PTE	SE	rts	TE	PTE	SE	rts	TE	PTE	SE	rts	TE	PTE	SE	rts
1	0.851	0.914	0.931	irs	0.924	0.939	0.984	irs	0.674	0.755	0.892	irs	0.829	0.846	0.98	irs
2	1	1	1	crs	0.995	1	0.995	irs	0.822	0.874	0.94	irs	0.974	1	0.974	irs
3	0.677	0.842	0.804	irs	0.634	0.774	0.819	irs	0.327	0.429	0.763	irs	0.739	0.829	0.891	irs
4	0.931	1	0.931	irs	0.895	1	0.895	irs	0.632	0.89	0.71	irs	0.914	1	0.914	irs
5	0.85	1	0.85	drs	0.828	1	0.828	drs	1	1	1	crs	0.861	1	0.861	drs
6	0.777	0.833	0.933	drs	0.877	0.95	0.922	drs	0.535	0.564	0.948	drs	0.927	1	0.927	drs
7	0.862	1	0.862	drs	0.838	1	0.838	drs	0.698	1	0.698	drs	0.845	1	0.845	drs
8	1	1	1	crs	1	1	1	crs	1	1	1	crs	1	1	1	crs
9	1	1	1	crs	1	1	1	crs	0.776	0.78	0.995	drs	1	1	1	crs
10	1	1	1	crs	1	1	1	crs	1	1	1	crs	0.996	1	0.996	drs
11	1	1	1	crs	0.889	0.935	0.952	irs	0.939	0.971	0.967	irs	1	1	1	crs
12	0.732	1	0.732	irs	0.68	1	0.68	irs	0.459	1	0.459	irs	0.747	1	0.747	irs
13	0.846	0.994	0.851	irs	0.804	0.943	0.852	irs	0.405	0.512	0.791	irs	0.874	0.968	0.903	irs
14	0.909	0.93	0.978	irs	0.707	0.743	0.952	irs	0.814	0.863	0.943	irs	0.807	0.843	0.958	irs
15	0.571	0.616	0.927	irs	0.587	0.609	0.964	irs	0.384	0.392	0.982	irs	0.682	0.698	0.977	irs
16	0.849	1	0.849	irs	0.875	1	0.875	irs	0.396	0.465	0.851	irs	0.877	0.957	0.917	irs
17	0.815	0.835	0.976	drs	0.874	0.877	0.997	irs	0.396	0.44	0.899	drs	0.984	1	0.984	drs
18	1	1	1	crs	1	1	1	crs	1	1	1	crs	1	1	1	crs
19	1	1	1	crs	1	1	1	crs	1	1	1	crs	1	1	1	crs
20	1	1	1	crs	1	1	1	crs	0.907	0.923	0.982	drs	0.962	1	0.962	drs
21	0.779	0.82	0.95	irs	0.849	0.883	0.961	irs	0.375	0.379	0.987	drs	0.996	1	0.996	drs
22	0.755	0.905	0.834	irs	0.589	0.81	0.727	irs	0.563	0.731	0.771	irs	0.631	0.815	0.774	irs
23	0.646	0.799	0.809	irs	0.588	0.781	0.754	irs	0.385	0.516	0.747	irs	0.687	0.816	0.843	irs
24	0.678	1	0.678	irs	0.69	1	0.69	irs	0.537	0.784	0.685	irs	0.78	1	0.78	irs
25	0.65	1	0.65	irs	0.743	1	0.743	irs	0.409	0.626	0.653	irs	1	1	1	crs
mean	0.847	0.94	0.902		0.835	0.93	0.897		0.657	0.756	0.867		0.885	0.951	0.929	

Note. SE = TE/PTE; rts stands for returns to scale; irs means increasing returns to scale; drs means decreasing returns to scale; crs means constant returns to scale.

Table 5 shows that, the management efficiency in the second stage, in the aspect of returns to scale, Miramar Garden Taipei and Evergreen Plaza Hotel (Tainan) maintained their scale efficiency at 1 throughout the 2006–

2011 period, indicating that their production scale was in the most appropriate condition. The operational efficiency of the Grand Hotel, Imperial Hotel Taipei, Landis Hotels and Resorts, 85 Sky Tower Hotel, Farglory Hotel, and Tayih Landis Hotel was under IRS, indicating that their business scales were too small and would have to increase the scale to achieve optimal condition. Meanwhile, Sheraton Grande Taipei Hotel, Grand Hyatt Taipei, Grand Formosa Regent, Shangri-La's Far Eastern Plaza Hotel, the Westin Taipei, Evergreen Laurel Hotel Taichung, and Hotel Royal Chiao Hsi were operating under DRS, meaning their business scales were too large and they would have to reduce input items to prevent waste of company resources.

Table 5. Management efficiency in the second stage

	2008				2009				2010				2011			
Firm	PTE	SE	TE	rts	TE	PTE	SE	rts	TE	PTE	SE	rts	TE	PTE	SE	rts
1	0.289	0.309	0.935	irs	0.273	0.295	0.923	irs	0.302	0.306	0.987	irs	0.29	0.31	0.934	irs
2	0.335	0.378	0.887	drs	0.322	0.631	0.51	drs	0.322	0.329	0.978	irs	0.299	0.433	0.69	drs
3	0.668	0.67	0.998	irs	0.67	0.704	0.952	irs	0.712	0.791	0.899	irs	0.725	0.736	0.985	irs
4	0.6	0.661	0.907	irs	0.639	0.647	0.987	irs	0.632	0.636	0.993	irs	0.644	0.673	0.957	irs
5	0.2	0.629	0.318	drs	0.195	0.604	0.323	drs	0.19	0.438	0.435	drs	0.19	0.54	0.352	drs
6	0.223	0.226	0.986	drs	0.23	0.241	0.952	irs	0.228	0.238	0.956	irs	0.223	0.262	0.852	irs
7	0.196	1	0.196	drs	0.209	1	0.209	drs	0.224	1	0.224	drs	0.205	1	0.205	drs
8	0.254	1	0.254	drs	0.243	1	0.243	drs	0.249	1	0.249	drs	0.244	1	0.244	drs
9	0.338	0.338	0.999	crs	0.349	0.413	0.846	drs	0.352	0.423	0.834	drs	0.332	0.357	0.929	irs
10	0.26	0.799	0.326	drs	0.24	0.506	0.474	drs	0.243	0.497	0.489	drs	0.242	0.362	0.67	drs
11	0.377	0.846	0.446	drs	0.359	0.643	0.559	drs	0.366	0.73	0.502	drs	0.351	0.569	0.617	drs
12	1	1	1	crs	1	1	1	crs	1	1	1	crs	1	1	1	crs
13	0.534	0.537	0.995	drs	0.494	0.516	0.957	irs	0.503	0.521	0.965	irs	0.508	0.532	0.955	irs
14	0.305	0.453	0.673	drs	0.284	0.363	0.782	drs	0.297	0.352	0.843	drs	0.284	0.287	0.989	irs
15	0.332	0.345	0.962	irs	0.298	0.341	0.874	irs	0.319	0.346	0.923	irs	0.311	0.366	0.849	irs
16	0.698	1	0.698	drs	0.685	1	0.685	drs	0.698	1	0.698	drs	0.67	1	0.67	drs
17	0.322	0.444	0.725	irs	0.432	0.435	0.992	irs	0.389	0.455	0.855	irs	0.364	0.456	0.797	irs
18	0.472	0.555	0.849	drs	0.487	0.723	0.674	drs	0.504	0.65	0.776	drs	0.484	0.714	0.678	drs
19	0.905	1	0.905	drs	0.897	1	0.897	drs	0.768	1	0.768	drs	0.673	0.702	0.959	irs
20	0.525	0.53	0.991	irs	0.595	0.901	0.66	drs	0.624	1	0.624	drs	0.566	1	0.566	drs
21	0.467	0.522	0.894	irs	0.513	0.514	0.999	crs	0.493	0.54	0.913	irs	0.453	0.544	0.832	irs
22	0.589	0.841	0.7	drs	0.622	0.679	0.916	drs	0.613	0.663	0.925	drs	0.622	0.687	0.905	irs
23	0.497	0.533	0.933	irs	0.543	0.685	0.793	irs	0.573	0.646	0.888	irs	0.54	0.675	0.799	irs
24	1	1	1	crs	1	1	1	crs	1	1	1	crs	1	1	1	crs
25	0.78	1	0.78	irs	1	1	1	crs	0.832	0.943	0.883	irs	0.726	0.773	0.938	irs
mean	0.487	0.665	0.774		0.503	0.674	0.768		0.497	0.66	0.784		0.478	0.639	0.775	

Note. SE = TE/PTE; rts stands for returns to scale; irs means increasing returns to scale; drs means decreasing returns to scale; crs means constant returns to scale.

4.2 Results of Cross-Period Longitudinal Analysis with the MI

Table 6 shows that the average total factor productivity in stage one is 1.109, indicating that the hotels were improving in operational efficiency in this stage. The Grand Hotel, the Ambassador Hotel, Gran Hyatt Taipei, the Ambassador Hotel Kaohsiung, Evergreen Laurel Hotel Taichung, Caesar Park Hotel and Resorts, the Ambassador Hotel Hsinchu, and Tayih Landis Hotel appeared declining in total factor productivity. From further analysis, it is evident that the reason for the decline for the Ambassador Hotel, Grand Hyatt Taipei, Caesar Park Hotel and Resort, and the Ambassador Hotel Hsinchu was due to deterioration in total technical efficiency. For the Ambassador Hotel, Grand Hyatt Taipei, and Caesar Park Hotel and Resorts, the deterioration in total technical efficiency was a result of falling scale efficiency. The Ambassador Hotel Hsinchu was the only sample whose deterioration in total technical efficiency had derived from decreasing pure technical efficiency. Meanwhile, the decline in operational efficiency of the Grand Hotel, the Ambassador Hotel Kaohsiung, Evergreen Laurel Hotel Taichung, and Tayih Landis Hotel was caused by production technique changes.

Table 6 also indicates that the total factor productivity average in the second stage is 1.002, meaning that the hotels were generally doing better in operational efficiency in the second stage. Imperial Hotel Taipei, Sheraton

Grande Taipei Hotel, Grand Formosa Regent, Shangri-La's Far Eastern Plaza Hotel, the Westin Taipei, Miramar Garden Taipei, the Ambassador Hotel Kaohsiung, the Grand Hi Lai Hotel, 85 Sky Tower Hotel, Evergreen Laurel Hotel Taichung, and the Lalu Hotel were down in total technical efficiency as a result of slumping scale efficiency. On the other hand, the deterioration in total technical efficiency of Sheraton Grande Taipei Hotel, Shangri-La' Far Eastern Plaza Hotel, the Westin Taipei, the Grand Hi Lai Hotel, and the Lalu Hotel was due to decrease in pure technical efficiency, whereas a similar occurrence happened to Imperial Hotel Taipei and Miramar Garden Taipei because of production technique changes.

Table 6. MI total factor productivity

Firm	Stage 1 MI Operational Efficiency					Stage 2 MI Management Effiiency				
	TE	PCH	PTE	SE	TFPCH	TE	PCH	PTE	SE	TFPCH
1	0.991	0.975#	0.975	1.017	0.967▽	1.001	1.019	1.001	1	1.019
2	0.991 *	0.996	1	0.991▼	0.988▽	0.963	1.013	1.047	0.92	0.975
3	1.03	0.977	0.995	1.035	1.006	1.028	0.992#	1.032	0.996	1.02▽
4	0.994	1.015	1	0.994	1.009	1.024	0.993	1.006	1.018	1.017
5	1.004	1.037	1	1.004	1.041	0.983 *	1.007	0.95☆	1.035	0.991▽
6	1.061	0.976	1.063	0.998	1.035	1	1.012	1.05	0.953	1.012
7	0.994 *	0.996	1	0.994▼	0.99▽	1.016	1.011	1	1.016	1.026
8	1	1.021	1	1	1.021	0.987 *	1.005	1	0.987▼	0.992▽
9	1	1.02	1	1	1.02	0.994	1.013	1.018	0.976	1.007
10	0.999	1.013	1	0.999	1.012	0.977 *	1.01	0.768☆	1.272	0.986▽
11	1	1.136	1	1	1.136	0.976 *	1.008	0.876☆	1.114	0.984▽
12	1.007	1.006	1	1.007	1.012	1	0.999#	1	1	0.999▽
13	1.011	0.976#	0.991	1.02	0.987▽	0.984 *	0.998	0.997	0.986▼	0.982▽
14	0.961	1.075	0.968	0.993	1.034	0.977 *	1.007	0.859☆	1.137	0.983▽
15	1.061	0.97	1.043	1.018	1.03	0.978 *	1.013	1.02	0.959▼	0.991▽
16	1.011	0.971#	0.985	1.026	0.982▽	0.987 *	1.009	1	0.987▼	0.995▽
17	1.065	0.95	1.062	1.003	1.011	1.041	1.008	1.009	1.032	1.05
18	1	1.129	1	1	1.129	1.009	1.015	1.087	0.927	1.023
19	1	1.015	1	1	1.015	0.906 *	0.996	0.889☆	1.019	0.903▽
20	0.987 *	1.003	1	0.987▼	0.99▽	1.025	1.007	1.236	0.83	1.033
21	1.085	0.946	1.068	1.016	1.026	0.99	1.017	1.014	0.976	1.006
22	0.942 *	1.005	0.966☆	0.975	0.947▽	1.018	1.005	0.935	1.089	1.024
23	1.021	0.972#	1.007	1.014	0.992▽	1.028	1.005	1.082	0.95	1.033
24	1.048	0.994	1	1.048	1.041	1	1.005	1	1	1.005
25	1.154	0.941	1	1.154	1.086	0.976	1.025	0.918	1.063	1.001
mean	1.016	1.004	1.005	1.011	1.019	0.994	1.008	0.988	1.007	1.002

Note. ▽ represents deterioration in total factor productivity, * deterioration in total technical efficiency, # deterioration in technical change rate, ▼ deterioration in scale efficiency, and ☆ deterioration in pure technical efficiency.

4.3 Management Matrix

With operational efficiency being the horizontal axis, management efficiency the vertical axis, and the MI's total factor productivity 1 being the critical value of each quadrant, the axes form the management matrix with four quadrants as shown in Fig. 2 and exhibits that the MI total factor productivity of Imperial Hotel Taipei, Landis Hotels and Resorts, Howard Hotels Resorts Suites, Farglory Hotel, Hotel Royal Chiao Hsi, Howard Beach Resort Kenting, Evergreen Plaza Hotel Tainan, and Formosan Naruwan Hotel & Resort exceeds 1 in operational efficiency and management efficiency. Same as the classification adopted by Yang and Lee (2013), these hotels are referred to as the leaders. The Grand Hotel, Grand Hyatt Taipei, Caesar Park Hotel and Resorts, the Ambassador Hotel Hsinchu, and Tayih Landis Hotel are the left flank followers, and Sheraton Grande Taipei Hotel, Grand Formosa Regent, Shangri-La's Far Eastern Plaza Hotel, the Westin Taipei, Miramar Garden Taipei, the Grand Hi Lai Hotel, 85 Sky Tower Hotel, and the Lalu Hotel are the right flank followers. Those with the MI way below 1 in both stages like the Ambassador Hotel, the Ambassador Hotel Kaohsiung, and Evergreen Laurel Hotel Taichung are apparently falling far behind the other five-star hotels in operational efficiency and management efficiency. In this study, they are referred to as the laggards.

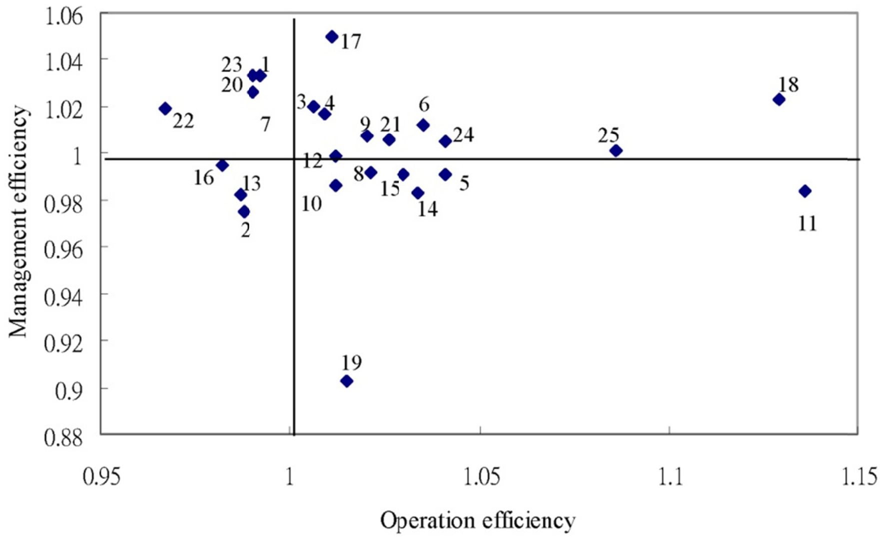

Figure 2. The management matrix

5. Conclusion

This study applies the CCR and BCC DEA models and the MI to examine the operational efficiency and management efficiency of five-star hotels in Taiwan during the 2006–2011 period. Initially, the models are used to conduct cross-section analysis of the performance of each hotel. After assessing the annual changes in operational efficiency and management efficiency, suggestions for the DMUs on how adjustments can be made to achieve the optimal scale condition are presented. The two-stage MI is applied to evaluate the total factor productivity and perform longitudinal cross-period analysis to distinguish whether the deterioration in total factor productivity comes from changes in total technical efficiency or production techniques or decline in pure technical efficiency or scale efficiency. A management matrix composed of productivity indices obtained with the two-stage MI is used to present the relative positions of the DMUs and a competitiveness status chart is established to facilitate further analysis and inference. At the same time, the high-efficiency leading group and the low-efficiency lagging group can also be identified in the matrix and this makes up for the lack of management information in past literature (Hwang & Chang, 2003; Wang et al., 2006; Assaf et al., 2010; Hu et al., 2010; Lee & Wang, 2012).

Those identified as belonging to the lagging group, namely the Ambassador Hotel, the Ambassador Hotel Kaohsiung and Evergreen Laurel Hotel Taichung, need to upgrade their operational efficiency and management efficiency as quickly as possible in order to catch up with the leading group. Meanwhile, the left flank followers, the Grand Hotel, Grand Hyatt Taipei, Caesar Park Hotel and Resorts, the Ambassador Hotel Hsinchu and Tayih Landis Hotel, have to improve their operational efficiency, whereas the right flank followers, Sheraton Grande Taipei Hotel, Grand Formosa Regent, Shangri-La's Far Eastern Plaza Hotel, the Westin Taipei, Miramar Garden Taipei, the Grand Hi Lai Hotel, 85 Sky Tower Hotel, and the Lalu Hotel require better management efficiency in order to ameliorate the overall management condition.

This study combines cross-period analysis using the MI and cross-section analysis with the CCR and BCC DEA models to assess the overall operational efficiency and management efficiency of five-star hotels in Taiwan as well as offer practical suggestions on how the hotels can adjust their production scales to achieve optimal scale.

Study Limitations and Suggestions for Further Studies

i. In this study, efficiency assessment is conducted on five-star hotels in Taiwan. However, many outstanding hotels have not participated in hotel star rating and therefore cannot be included as samples. In the future, researchers can keep track of such hotels and include them as samples for assessment in order to increase accuracy in analysis of five-star hotels.

ii. This study is conducted only on the overall efficiency of five-star hotels in Taiwan. In the future, researchers may also obtain data on the five-star hotels in another country in order to compare the differences in operational efficiency in between.

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