Total factor productivity growth and regional competitive analysis of China's star-rated hotels

Abstract

This study investigates the total factor productivity (TFP) growth, technological progress, pure technical efficiency change, scale efficiency change, and mix efficiency change of star-rated hotels in China by employing a Hicks–Moorsteen index approach. The results show that the TFP of star-rated hotels in China had an annual average growth rate of 13.11%, mainly attributed to an annual average growth rate of operational efficiency of 21.85% and a mix efficiency growth rate of 13.52%. The growth rate of optimal production technology in the Western region markedly outperformed those in other regions and yet its growth rate of operational efficiency significantly under-performed. We also found that catch-up effects in the Central and Western regions were progressing in terms of operational efficiency and optimal production technology, respectively. The findings suggest that policy makers and practitioners should focus on TFP growth and its components, drawing the attention of star-rated hotels to upgrade their optimal production technology and enhance their operational efficiency as a means of improving TFP and competitiveness. Lastly, this study advances a new research perspective in efficiency assessment in the hotel industry by considering both financial and service production outputs.

Keywords

total factor productivity, hotel, efficiency, Hicks-Moorsteen index, competitive analysis

Introduction

China has become the second top destination for both international tourism receipts and tourist arrivals, and is likely to continue playing an important role in the tourism industry worldwide benefiting from its strong currency and fast growing economy

(United Nations World Tourism Organization, 2016; China National Tourism Administration (CNTA), 2016). Its 2015 tourist arrivals reached 133.82 million, of which 56.88 million stayed overnight with an average stay of 3.26 days, increasing from 3.15 days in 2014 (CNTA, 2016). Total expenditure of inbound tourists amounted to USD 114 billion in 2015, more than doubling from USD 45.81 billion in 2010. One main driver supporting China's strong tourism performance was the rapid development of the hotel industry, particularly of star-rated hotels (Tsai, 2009) which, from 2005 to 2014, accounted for an average of 78.7% of revenue from the hotel industry nationwide (National Bureau of Statistics of the People's Republic of China, 2016).

While the hotel operational environment in China has changed dramatically since the early 1980s when the hotel industry started to develop (Zha and Li, 2017), the observed growth of star-rated hotels through extensive capital expansion may not be sustainable if demand does not catch up with supply, resulting in resources lying idle. The industries in China have transformed from extensive to intensive growth (Chen, 2009); quality improvement and efficiency of economic growth have been paid more attention. In particular, tourism was a highlight of economic reform and its development has contributed significantly to the national economy (Tsang and Hsu, 2011). Such a significant developing phenomenon of the hotel industry in China under a rapidly changing economic environment urges a need for a more precise approach that focuses on productivity evaluation and improvement (Huang et al., 2012). On the other hand, the government plays an important role in shaping the development of the tourism industry through policy setting and guidance (Zhang et al., 2008). In providing the star-rated hotel industry with effective management suggestions and policy, it is high time to measure the productivity growth and effectiveness of resource utilization in the star-rated hotel industry in China.

Productivity measurement is one important issue in the production of tourism activities, including hotel services (Phillips, 1999; Luo et al., 2014). In particular, total factor productivity (TFP) is a critical indicator, reflecting the magnitude of total output growth relative to that of the growth in traditionally measured inputs of labor and capital, or the ratio of output to input used in production (Cordero and Tzeremes, 2017). An accurate measurement of hotel productivity measurement in terms of TFP growth and its components is useful for not only effective industrial and business policy-making (O'Donnell, 2010) but also national and regional tourism planning and development (Huang et al., 2012), thus leading to increased profitability for the hotel industry (Witt and Witt, 1989; Peypoch and Solonandrasana, 2008).

Conventionally, hotel industrial performance could be measured by using single dimensional indicators/ratios, such as average occupancy rates (Oses et al., 2016), relative efficiency (Arbelo et al., 2017) or partial productivity indicators (Assaf and Agbola, 2011; Sigala and Mylonakis, 2005). The majority of hotel productivity-related studies are microcosmic in nature and based on cross-sectional data at the individual level of hotels; a more holistic performance measure such as TFP growth at the industrial level has received relatively scant attention in the hotel industry in China. Therefore, our research aims to fill the research void and measure TFP growth of China's star-rated hotels at the aggregate level of the regional hotel industry (Cracolici et al., 2008; Huang et al., 2012; Tsai, 2009) using a Hicks-Moorsteen index approach (O'Donnell, 2010) to monitor TFP growth, technological progress and changes in various efficiencies over time. Moreover, the present study could provide both development suggestions to decision-makers and practitioners and a practical example to other countries and regions undergoing rapid transition in the development of their hotel industry, and fills the gap by focusing on the antecedents of TFP growth of the hotel industry at the regional level in China.

Performance assessment in the hotel industry

Previous studies assessed hotel performance by applying various financial indicators, mainly focusing on profitability measures such as return on assets (Chen, 2010; Kim et al., 2002; Rudež and Mihalič, 2007) or return on investment (Jang and Yu, 2002; Wu and Liang, 2009; Xiao et al., 2012), among others. Nevertheless, such indices are largely confined to the measurement of final operational outcomes, ignoring the efficiency of resource input utilization (Tsai et al., 2011) and neglecting the multidimensional aspects of hotel industry operations (Yu and Chen, 2016). To tackle such deficiency, some scholars introduced parametric approaches such as stochastic frontier analysis (SFA) by considering multiple inputs and outputs of a hotel and assess its efficiency by measuring its deviation from an optimal frontier (Arbelo et al., 2017; Assaf, 2012; Barros, 2004; Barros, 2006; Chen, 2007; Lin, 2011). Additionally, another common approach in efficiency assessment is a non-parametric approach of data envelopment analysis (DEA) (Charnes et al., 1978), in which an efficiency frontier is constructed in reflecting a firm's minimum resource usage for a given level of output (Liu et al., 2018).

The DEA technique has been applied in a number of hotel efficiency studies (e.g., Aissa and Goaied, 2016; Barros and Dieke, 2008; Barros et al., 2010; Detotto et al., 2014; Huang, 2017; Oliveira et al., 2013; Yin et al., 2015). In particular, some studies such as Peng and Chen (2004), Pine and Phillips (2005), and Chan (2012) focused on China's hotel industry; analogously these studies found that hotel performance in terms of efficiency is significantly different across different regions and star ratings. To our best knowledge, only Huang et al. (2012) carried out a dynamic efficiency assessment on China's hotel industry during 2001—2006 at the aggregate level of the regional hotel industry. The techniques of SFA and DEA not only have been applied extensively in hotel efficiency evaluation research (Yin et al., 2015) but also could be used in deriving productivity measures.

Productivity refers to the ratio of outputs over inputs yielding an absolute measure of performance that may be applied to multiple inputs and outputs through aggregation (Bernini and Guizzardi, 2010); productivity growth is a relative measure of productivity changes between different years. On the basis of SFA, Barros (2006) used a translog frontier model and the maximum likelihood estimation technique to estimate the technology change in Portuguese hotel industry. Chen and Soo (2007) employed a multi-product translog cost function to investigate productivity growth of the hotel industry in Taiwan. Kim (2011) also employed a translog function to examine TFP growth of the hotel industry in Malaysia. While the SFA technique could handle random disturbance (Coelli et al., 2005), it has some major constraints on production function assumptions and sample size (Zha and Li, 2017).

To the contrary, the DEA technique does not require any specification on the functional relationship between input and output variables (Banker et al., 1984). Färe et al. (1994) investigated productivity development in Swedish hospitals using the Malmquist output index approach; Barros (2005) evaluated the performance of hotels in Portugal with a Malmquist TFP index and decomposed the index into technical progress and changes in technical efficiency. Furthermore, Assaf et al. (2010) and Assaf et al. (2011) employed a bootstrapped Malmquist TFP index approach to assess the efficiency of hotels in Taiwan and Australia, respectively. More recently, Yu and Chen (2016) also measured productivity growth of the hotel industry in Taiwan from 2008 to 2011 by using the metafrontier Malmquist TFP index.

While the Malmquist TFP index has been applied in hotel studies, its properties are maintained under constant returns to scale rather than variable returns to scale, and it generally is less applicable in interpreting TFP (Grifell-Tatjé and Lovell, 1995; Kerstens and Woestyne, 2014). O'Donnell (2010) criticized the Malmquist TFP index for its limited ability in TFP decomposition and developed a DEA-based methodology to decompose the multiplicative Hicks–Moorsteen TFP index into technical change, pure technical efficiency change, scale efficiency change, and mix efficiency change, which provides a more general notion of TFP as expressed by a ratio of change in aggregate output to that in aggregate input (Peyrache, 2014). The Hicks–Moorsteen TFP index could generally be derived through Shephard's distance function because of the index's multiplicative nature (O'Donnell, 2010). Even though the directional distance function (DDF) is a complete generalization of Shephard's distance function, McFadden's gauge function, and the directional input and output (Chambers and Chung, 1998), the DDF is more useful in calculating the TFP index when undesirable or negative output is present (Luenberger, 1992; Briec and Kerstens, 2004).

Therefore, to investigate the TFP change of star-rated hotels at the regional level in China in a more comprehensive manner and to offer relevant developmental directions for the hotel industry across different regions, we employed the Hicks–Moorsteen TFP index approach through Shephard's distance function in this study.

Framework

Conventional measures of TFP change could not completely distinguish between technological progress and changes in various efficiencies even though progress and various changes are analytically distinct and may have quite different practical implications (Nishimizu and Page, 1982). The current research adopts an efficient frontier approach by employing a DEA-based Hicks–Moorsteen TFP index that breaks down changes in TFP into technological progress and changes in operational efficiency. To provide a framework for the productivity measurement of star-rated hotels in China, the measures developed in recent years and outlined in other papers are adopted by this study (O'Donnell, 2010, 2012; Kerstens and Van de Woestyne, 2014), described in the following section.

Technology level

In the case of a single-input, single-output firm, its technology level (TL) reflects its productivity, which is a ratio of the production output to the input factor that made the output possible (Fried et al., 1993). In contrast, if the firm uses multiple inputs to produce multiple outputs, then the inputs and outputs ought to be aggregated so that its productivity measure remains a ratio of two scalars.

Let $x_{ij}^t = (x_{1j}^t, x_{2j}^t, \dots, x_{mj}^t)$ and $y_{rj}^t = (x_{1j}^t, x_{2j}^t, \dots, x_{sj}^t)$ denote the observed input vector and output vector, respectively, of hotel j in period t. $i \in (1, 2, \dots, \mathrm{m})$ is the ith input and $r \in (1, 2, \dots, \mathrm{s})$ is the rth output. Furthermore, let $X_j = X(x_j)$ and $Y_j = Y(y_j)$ denote the aggregate input and output, and $X(.)$ and $Y(.)$ the non-decreasing linearly homogeneous aggregator functions, which means that hotels in different periods have the same input and output vectors and the same production function. With this definition, a hotel's TL could be expressed as:

$$TL_j^t = Y_j^t / X_j^t \qquad (1)$$

$$TL^{t*} = Y^{t*} / X^{t*} \qquad (2)$$

where, $t=1,2, \dots, T$; $j=1,2, \dots, N$; $i=1,2, \dots, m$; $r=1,2, \dots, s$; Equation (1) is an observed production technology level of hotel j in period t, and Equation (2) is the optimal production technology level of hotel(s) in period t subject to the constraint of technology.

Hicks–Moorsteen TFP index

With the above definition, the index that compares the TFP of hotel *j'* in period *t'* with that of hotel *j* in period *t* is as follows:

$$TFP_{j,j'}^{t,t'} = \frac{TL_{j'}^{t'}}{TL_j^t} = \frac{Y_{j'}^{t'}/X_{j'}^{t'}}{Y_j^t/X_j^t} = \frac{Y_{j,j'}^{t,t'}}{X_{j,j'}^{t,t'}} \qquad (3)$$

where, *t'=1, 2, …, T*; *j'=1, 2, …, N*; $Y_{j,j'}^{t,t'} = Y_{j'}^{t'}/Y_j^t$ is the output quantity index and $X_{j,j'}^{t,t'} = X_{j'}^{t'}/X_j^t$ is the input quantity index. Equation (3) demonstrates that TFP change can be written as an index of output growth divided by an index of input growth.

O'Donnell (2010) asserts that, the Hicks–Moorsteen TFP (TFP_{HM}) index based on DEA could be denoted as:

$$TFP_{HM}^{jt,j't'} = \left(\frac{\dfrac{d_O^{t'}\left(x_{j'}^{t'}, y_{j'}^{t'}\right) d_O^t\left(x_j^t, y_{j'}^{t'}\right)}{d_O^{t'}\left(x_{j'}^{t'}, y_j^t\right) d_O^t\left(x_j^t, y_j^t\right)}}{\dfrac{d_I^{t'}\left(x_{j'}^{t'}, y_{j'}^{t'}\right) d_I^t\left(x_{j'}^{t'}, y_j^t\right)}{d_I^{t'}\left(x_j^t, y_{j'}^{t'}\right) d_I^t\left(x_j^t, y_j^t\right)}} \right)^{1/2} \qquad (4)$$

Here, *d* is the Shephard distance function, and the subscripts *O* and *I* are output-orientation and input-orientation, respectively.

Decomposition of TFP_{HM} index

According to Farrell (1957), the operational efficiency (E) of hotel *j* in period *t* could be denoted as:

$$E_j^t = \frac{TL_j^t}{TL^{t*}} \ll 1 \qquad (5)$$

TL_j^t and TL^{t*} are denoted in Equations (1) and (2) and could be measured in terms of aggregate quantities. Here, the observed production technology level of hotel *j* in period *t* (TL_j^t) is not more than the optimal production technology level of hotels in period t (TL^{t*}). The efficiency measures that feature in the decomposition of the operational efficiency (E) are pure technical efficiency (PTE), scale efficiency (SE), and residual mix efficiency (RME), all of which are in line with Charnes et al. (1978), and Banker et al. (1984). On the basis of Equation (5), Equation (3) could be further decomposed:

$$TFP_{j,j'}^{t,t'} = \frac{TL^{t'*}}{TL^{t*}} \times \frac{PTE_{j'}^{t'}}{PTE_{j}^{t}} \times \frac{SE_{j'}^{t'}}{SE_{j}^{t}} \times \frac{RME_{j'}^{t'}}{RME_{j}^{t}} \qquad (6)$$

Finally, the $\mathrm{TFP_{HM}}$ index could be decomposed following Equation (6). The detailed calculation process of $\mathrm{TFP_{HM}}$ index and its decomposed efficiencies can be seen in O'Donnell (2010). When the value of $\mathrm{TFP_{HM}}$ is greater than, equal to, or less than one, the TFP increased, remained unchanged, or decreased, respectively.

The term, $\frac{TL^{t'*}}{TL^{t*}}$, on the right-hand side of Equation (6) is a measure of technological progress (denoted as △Tech), which reflects the difference between the maximum productivity possible using the period-*t'* technology and the maximum productivity possible using the period-*t* technology. The other ratios on the right-hand side of Equation (6) are measures of change in pure technical efficiency (denoted as △PTE) representing the efficiency level achieved as a result of management effort, change in scale efficiency (denoted as △SE) representing the efficiency level of a hotel against one that is operating at an optimal scale over the long term, and change in residual mix efficiency (denoted as △RME) representing the efficiency level achieved as a result of a mix of various outputs (Joo et al., 2009; O'Donnell, 2012). The product of △PTE, △SE, and △RME is the change in operational efficiency

(△E) representing how well star-rated hotels actually process various inputs to achieve outputs (Barros, 2005). In our research, the TFP_{HM} index of star-rated hotels in China is measured every two years during the observation period. Accordingly, period t'=t+1.

In our study, technological progress (△Tech) is the consequence of innovation or the adoption of new technology by best practice hotels on the optimal production technology level. TFP change is the product of the growth rate of technological progress and changes in various efficiencies (△PTE, △SE, and △RME). We should note that a high growth rate of technological progress could co-exist with deteriorating efficiencies, perhaps due to failures in achieving technological mastery that could lead to resources being wasted or insufficient outputs, and thus the overall growth rate of TFP could be either positive or negative. Similarly, a relatively low growth rate in technological progress could co-exist with rapidly improving efficiencies. Therefore, on the basis of a detailed performance decomposition, suggestions to improve the rate of TFP growth could be better devised. For example, firms should focus on accelerating their rate of innovation in circumstances where slow hotel TFP changes were observed due to a low rate of diffusion of the optimal production technology.

Data and variables

The method used in this study requires the identification of input and output variables for inclusion in the TFP function. The selection of variables should represent the inputs and outputs used by China's hotel industry in its service production process and the results obtained in empirical research performed prior to the investigation (Such Devesa and Mendieta PEÑALVER, 2013). For a TFP study, each input is classified as either an indicator of labor or capital reflecting resources such as staff, capital and equipment deployed in producing tangible products and intangible services (Yasin et al., 1997; Zhou et al., 2008; Huang et al., 2012). As a result, we considered two inputs (i.e., number of employees and the amount of fixed assets) to denote human resources and capital deployment (Kim, 2011). Output variables could include those besides revenue and thus ‘total operating revenue’ and ‘room nights sold’ were selected to denote the financial and service production outcomes. The input and output indexes we selected were also adopted by Barros (2006, 2008), Kim (2011), and Yin et al. (2015).

In our study, since the hotel TFP change was analyzed from the perspective of both industrial and regional development, the hotels in China's 31 respective provinces and municipalities were regarded as 31 unique decision-making units (Huang et al., 2012). According to the Seventh Five-year Plan of the Chinese government considering the differences in regional economic development, these 31 provinces and municipalities in China can be divided into Eastern, Central, and Western regions (Liu et al., 2017), as shown in Table 1.

[Insert Table 1 here]

To estimate the TFP change of star-rated hotels in China, provincial panel data obtained from the CEIC Database and Statistical Yearbook of China were used. For the sample period 2001 to 2015, a total of 465 observations, including 31 provinces and municipalities in mainland China were included. Table 2 shows the descriptive statistics of the input and output variables used for TFP change assessment.

[Insert Table 2 here]

From Table 2 we can see that while the median of the number of employees in the Western region was the lowest, the median of the fixed assets was the highest and the S.D. was lowest in the Western region. The maximum fixed assets and total revenue in the Central region were higher than those in other regions, but the number of room nights sold in the Eastern region was the highest.

Results and analysis

According to our framework, the TFP_{HM} by year was calculated and then separated into technological progress (△Tech) and operational efficiency changes (△E). The TFP_{HM} can be explained by its components △Tech and △E, respectively. Moreover, △E was further decomposed into pure technology efficiency change (△PTE), scale efficiency change (△SE), and residual mix efficiency change (△RME). The results of TFP_{HM} and the various decomposed values are listed in Tables 3 and 4.

Regional performance analysis

Table 3 shows that the star-rated hotels had TFP growth (TFP_{HM} > one) in eight out of 14 years but a reduction (e.g., TFP_{HM} < one) in the other six years. The average value of TFP_{HM} exceeded one, indicating that the star-rated hotels had gained an average of 13.1% TFP growth per annum during the sample period. Both the technological progress (1.56%) and efficiency change (21.85%) played a positive role in supporting the growth of star-rated hotels in China. From these results we can see that the operational efficiency growth was the main driving force for TFP in the star-rated hotels. In particular, the annual average growth rate of mix efficiency was 13.52%, outperforming those of PTE and SE. Generally speaking, the output productivity reflected by revenue and room nights sold demonstrated good growth momentum. More importantly, the high growth rate of mix efficiency reveals that the mixed output of revenue and room nights sold continually improves, which means that the coordination between commercial profit (i.e., revenue) and hospitality services (i.e., room nights sold) is also improving.

[Insert Table 3 here]

While the productivity of star-rated hotels shows a rising trend, the TFP_{HM} fluctuated. The TFP_{HM} showed a remarkable 116.08% growth from 2004 to 2005; however, it also experienced a significant drop in 2013 of 39.73%. This increase or decrease in hotel TFP may depend on different driving forces. Taking TFP_{HM} in 2008 to 2009 and 2013 to 2014 as an example, while the improvement of TFP_{HM} from 2008 to 2009 (i.e., 7.18%) was mainly attributed to positive technological progress ($\triangle$Tech = 32.2% and $\triangle$E = -9.4%), from 2013 to 2014 (i.e., 91.39%) it was mainly derived from operational efficiency improvements ($\triangle$Tech = -23.08% and $\triangle$E = 191.07%).

As stated earlier, regional economic development in China is uneven, which could have influenced the growth of the hotel industry and management decision making (Chen, 2007). Table 4 shows the evolutionary TFP_{HM} trend in star-rated hotels in the Eastern, Central, and Western regions.

In the Eastern region, eight out of 14 TFP changes were progressive from 2001 to

2015. While the annual average TFP_{HM} had an increase of 13.38%, mild technological regression (△Tech =0.9907) impeded further improvement in TFP_{HM}. The average improvement of operational efficiency reached 19.28% and it was this unique impetus that stimulated the TFP_{HM} growth of star-rated hotels in the Eastern region. In particular, the pure technical efficiency, scale efficiency, and mix efficiency had an annual increase of 3.57%, 4.37%, and 9.62%, respectively, meaning that the management level, returns to scale, and the mixture of outputs improved. The level of average △Tech (i.e., 0.9907) indicates that the optimal production technology of star-rated hotels in the Eastern region did not progress, instead they regressed 0.93% slightly. That is, the management level of star-rated hotels was basically at a standstill during the sample period although the level of economic development in the Eastern region expanded rapidly.

[Insert Table 4 here]

Compared with the Eastern region, the evolutionary trend of star-rated hotels' TFP_{HM} in the Central region shows an analogical but more conspicuous performance: only five out of 14 TFP_{HM} changes were progressive from 2001 to 2015. While the annual average TFP_{HM} and technology change showed an increase of 14.55% and regression of 1.27%, respectively, the annual average increase of operational efficiency of star-rated hotels in the Central region was greater than that of the Eastern region, reaching 33.74%. That is, star-rated hotels in the Central region exhibited a stronger catch-up effect in terms of operational efficiency (Cook, 1989), meaning that the star-rated hotels in the Central region transformed their resource inputs into production outputs more efficiently, and the diffusion of optimal production technology was better than those in the Eastern region. Specifically, the annual average △RME was equal to 1.2046, which means that the optional mixture of outputs played the most important role in the catching up effect. However, the disappointing performance of technological progress (annual average △Tech = 0.9873) discloses that the optimal production technology showed a regressive trend in star-rated hotels in the Central region, even worse than that in the Eastern region.

Though economically underdeveloped, the Western region was the only region with an annual average △Tech exceeding one (i.e., 1.0637), meaning that the optimal production technology of star-rated hotels in the Western region progressed by 6.37% annually from 2001 to 2015. However, the average increases in TFP_{HM} (i.e., 11.65%) and operational efficiency (i.e., 14.68%) of star-rated hotels in the Western region were the lowest compared to those of the other two regions. In other words, while both the technological progress and operational efficiency improvement together drove the TFP_{HM} increase of star-rated hotels in the Western region, the Western region's slower TFP_{HM} increase was mainly caused by inferior performance of its operational efficiency improvement. That is, the utilization and diffusion of optimal production technology in star-rated hotels in the Western region was subordinate to those in the other two regions.

Besides regional development characteristics, there are some commonalities in performance of the star-rated hotels among the three regions. First, the TFP_{HM} and operational efficiency of star-rated hotels in the three regions all averagely increased. Second, the growth rates of mix efficiencies of the star-rated hotels in the three regions were the highest among the various efficiency changes. Last, the level of TFP_{HM} was unstable both regionally and nationally. Meanwhile, as we expected, there was some difference in performance between regional and national perspectives. That is, the production technology progress of the star-rated hotels nationally was best reflected by those in the Western region as those in other regions showed a regression.

Integrated performance analysis

Improving productivity is a long term task in the hotel industry (Kilic and Okumus, 2005), which signifies that a time sequence analysis of star-rated hotels is necessary and could help managers better understand the development of the industry. Accordingly, on the basis of cumulative yearly values, we depict the TFP_{HM} and its components of star-rated hotels, nationally and regionally, in Figures 1 to 3. The intercept of the dotted line is equal to one in Figures 1 to 3, above this line means an increase of TFP_{HM} while below means otherwise.

[Insert Figure 1 here]

From Figure 1 we can see that the trend lines of the cumulative TFP_{HM} of hotels in all regions is, more or less, mimicked by them all. In general, the TFP_{HM} of the star-rated hotels has progressed positively, but with some fluctuations in most years in the sample period, and only declining in a few years. After a short, sustained drop from 2001 to 2003, the TFP_{HM} of the star-rated hotels in the Western region took the lead in 2004. From 2004 to 2012, the TFP_{HM} of the star-rated hotels in all three regions showed positive growth in spite of different paces. It is worth noting that the TFP_{HM} of both Eastern and Central regions plummeted in 2013 and thereafter the TFP_{HM} of all the regions resumed a positive growth. The two noteworthy TFP declines of the star-rated hotels happened in 2003 and 2013, respectively. In 2003, the SARS outbreak in China caused a sharp drop in visitors, contributing to a fatal blow to the hospitality industry in Asia, especially China (Chen, 2007; Chen et al., 2007). Compared with the cause of the TFP_{HM} drop in 2003, the underperformance of TFP_{HM} change in the star-rated hotels in 2013 was most likely due to a, then, new policy (Zhao, 2014) related to ‘the eight rules’ and a nationwide petition about frugality in the hotel industry mandated by the Political Bureau of the Central Committee and China Tourist Hotels Association in December 2012 and January 2013 (People.cn, 2014), respectively.

[Insert Figure 2 here]

As one of the two driving forces of TFP_{HM}, the performance of technological progress (△Tech) is like a wave throughout the years in the sample period as shown in Figure 2. By the end of the sample period, the optimal production technology of the star-rated hotels in all regions had virtually not progressed, except in the Western region. Meanwhile, the optimal production technology of the star-rated hotels had a sharp decline in 2002 to 2003 and 2013 to 2014, respectively, which may not be related to the operational environment under the influence of emergent matters or changes in policy. In addition, it can be seen in Figure 2 that the optimal production technology progress of the star-rated hotels in the Western region was the most noteworthy and the changes in optimal production technology in the Eastern and Central regions were under the dotted line every year except 2009. Combined with the previous regional analysis, we can infer that continuous progress of optimal production technology played an important role in the catch-up of the Western region.

Finally, there are some interesting findings worthy of note. First, the highest gain of cumulative $\triangle$Tech in the star-rated hotels happened during 2008 to 2009 when the global financial crisis broke out. Second, the performance of the cumulative $\triangle$Tech showed a rebound in 2015 after a decline from 2013 to 2014, this may be attributed to the fact that China's star-rated hotels had completed their transition following the government's corruption crackdown efforts, especially in the food and beverage industry (Zhao, 2014).

[Insert Figure 3 here]

As the other driving force, the cumulative growth of operational efficiency ($\triangle$E) depicted in Figure 3 has been above the dotted line since 2004, although some slower growths were observed in 2009 and 2013, respectively, meaning that operational efficiency has generally improved. Unlike the performance of optimal production technology, the operational efficiency improvement was affected in 2009 and 2013, through which the TFP_{HM} growth of the star-rated hotels was also affected and appeared unstable as previously described. In addition, by combining Figures 1 and 2 we can see that the improvement of the TFP_{HM} growth rate in 2014 was mainly attributed to the astonishing increase in cumulative $\triangle$E, shown in Figure 3. It is also worth noting that the influence of the global financial crisis during 2008 and 2009 on star-rated hotels in China was not significant; the main reasons could be that the active policies in China, not only offset the influence of the global financial crisis, but also simultaneously stimulated the consumption of domestic tourism, which demonstrates the essential need for government to take an active role in the development of tourism (Chin et al., 2013).

Competitive analysis

The higher the operational efficiency and the more advanced the technology, the greater the competitiveness and the greater the development potential (Cracolici et al., 2008). In order to analyze the competitiveness and development potential of star-rated hotels at a provincial level, we measured the average values of △Tech and △E, respectively, of all administrative regions during the sample period. Using the results, we depict a four-quadrant diagram in which the horizontal axis is △Tech, with one being a division value, and the vertical axis is △E, with the provincial average value as a division value. The 31 provinces and municipalities were divided into four groups and are depicted in quadrants accordingly, as shown in Figure 4.

[Insert Figure 4 here]

In Figure 4, we can see that in Quadrant I △E is greater than the average value and △Tech is greater than one. In other words, the development potential of the star-rated hotels in the administrative regions in this quadrant was good and their competitiveness was improving because their diffusion of optimal technology was fast and their optimal production technology was progressing. In Quadrant II where △E is greater than the average value and △Tech is less than one, development potential and competitiveness improvement in the star-rated hotels in the administrative regions in this quadrant were observed but were limited because the diffusion of optimal technology was fast but their optimal production technology was regressing. In Quadrant III where △E is less than the average value and △Tech is less than one, the development potential was limited and competitiveness of the star-rated hotels in the administrative regions in this quadrant was getting worse because the diffusion of optimal technology was slow and their optimal production technology was regressing. In Quadrant IV where △E is less than the average value but △Tech is greater than one, the development potential for most of the hotels in this quadrant showed little change but the competitiveness of the 'best practice' hotels improved because the diffusion of optimal technology was slow but their optimal production technology was progressing.

Inconsistent with the status of regional economic development, we can see from Figure 4 that the performance of the start-rated hotels in most of the Eastern administrative region was not promising in terms of technological progress. Take Beijing and Shanghai as an example, while they are undoubtedly the most developed cities in the Eastern region, or even in mainland China, even though their production technology diffusion and resource utilization for star-rated hotels shows efficiency, their production technology regression (△Tech < one) was more obvious than in other provinces and cities and deteriorated gradually; such observations do not correspond to the continuous regional economic development in Beijing and Shanghai. In contrast, the technological progress performance in the Western region and the efficiency improvement performance in the Central region were surprising. While the economic development was not as good as that in the Eastern region, the operational efficiency of the star-rated hotels in most of the Central region (filled dots in Figure 4) and the optimal productivity of the star-rated hotels in most of the Western region (triangles in Figure 4) outperformed those of the Eastern region.

Implications

Our study offers several theoretical and practical contributions. Theoretically, we applied the Hicks-Moorsteen index model (O'Donnell, 2010) to star-rated hotels in China in assessing TFP change along with changes in various efficiency measures. The findings confirmed that the approach could completely decompose the operational efficiency, and provides an additional research perspective on efficiency assessment in the hotel industry. In addition, the findings of our study verified quantitatively the statement of Zhao (2014) that the policies of 'the eight rules' and the 'nationwide petition about frugality in the hotel industry' have a short-term and negative effect on industry performance but may have a positive effect on the industry-wide restructuring of star-rated hotels. Third, we also addressed a gap in the literature on TFP change assessment of star-rated hotels nationally and regionally in China by proposing a Hicks-Moorsteen index approach, based on DEA, considering financial and service production outputs, offering further research opportunities.

Practically, the findings on the annual increase of star-rated hotels' TFP_{HM} (13.11%) in China, mainly relying on $\triangle E$ (21.85%) rather than $\triangle Tech$ (1.56%), indicates that the diffused utilization of optimal production technology is superior to the pace of technological innovation. This should urge star-rated hotel owners and management companies pay more attention to introducing and employing advanced production technology and service equipment to continue improving the TFP of the regional hotel industry. Second, in tackling low occupancy rates coupled with increasing amount of fixed asset investment and limited growth of scale efficiency, hotel industrial stakeholders including owners and government authorities in charge of hotel development should consider limiting and monitoring the size of fixed asset investment in star-rated hotels in China to improve economic efficiencies of scale. Third, from the results of long-term stagnant or slightly declining optimal production technology observed in star-rated hotels, practitioners in the Eastern and Central regions could strengthen their technological progress by learning and applying advanced management skills rather than being complacent about past achievements. In addition, the rapid development of the Western region's star-rated hotels in optimal technology demonstrates that China's Western Development Strategy (Yu, 2015) has been favorable for star-rated hotels. Furthermore, the result that the diffusion of optimal production technology for star-rated hotels in the Western region was inferior to those in other regions (accumulative $\triangle E$ in Figure 3) reminds managers that they should not only focus on benchmarking and learning from 'best practice' hotels but also pay more attention to strengthening communication among hotels in the Western region to achieve optimal production technology from an industrial perspective. Fourth, practitioners of star-rated hotels in China should be sensitive to the influence of government policies such as 'the eight rules' and respond quickly to develop new business opportunities suitable to the ever-changing operating environment. For example, hotels could alter their marketing strategies toward leisure travelers rather than relying on government-related income sources. Finally, decision makers in different provinces and municipalities could develop strategies to improve the competitiveness of their star-rated hotels in line with the competitive position analysis provided in our study. Take Shaanxi Province, located in the fourth quadrant in Figure 4 as an example. The focus of the star-rated hotels in Shaanxi should appreciate and adopt the use of optimal production technology from best-practice hotels within Shaanxi rather than bringing in advanced technology from other provinces. In other words, internal benchmarking against hotels within the province to improve the operational efficiency of star-rated hotels is the most important issue.

Conclusion

In this paper, we proposed the Hicks–Moorsteen TFP index approach based on DEA by considering both financial and service production outputs to investigate the TFP change at the regional level. The index is then further decomposed into technological progress, pure technical efficiency change, scale efficiency change, and mix efficiency change of star-rated hotels in China, both nationally and regionally. As such, the present study makes three major contributions. First, unlike previous tourism and hospitality studies that mainly used the Malmquist index model, the present study employed the Hicks–Moorsteen TFP index approach based on DEA in examining the TFP growth, technological progress and changes in various efficiency in particular the mix efficiency change, thus further enhancing the understanding of hotel TFP and technological progress. While previous studies generally analyzed hotel productivity in terms of relative efficiency, this study extends the scope of productivity assessment to macro socio-economic environment at the regional level. Second, the present study introduces a novel two-dimensional technological progress and efficiency change-based matrix diagram to assess the competitive advantage of the hotel industry across different regions in China. Finally, the implications resulting from the present study allow regional government policy makers to benchmark the best regional hotel industry's performance and offer policy guidelines.

Based on our assessment of star-rated hotels, the current study found that while the performance of TFP_{HM} had some fluctuations during the sample period, the TFP of star-rated hotels in China had an annual average growth rate of 13.11%, mainly attributed to an annual average growth rate of operational efficiency of 21.85% and, in particular, a mix efficiency growth rate of 13.52%. From a regional perspective, for the star-rated hotels in the Eastern region, we found that while the average TFP had an annual increase of 13.38%, which was mainly supported by an annual improvement of 19.28% in operational efficiency, the technical efficiency regressed mildly ($\triangle$Tech =0.9907); for the star-rated hotels in the Central region, the annual average changes in TFP and in technology had an increase of 14.55% and a regression of 1.27%, respectively. Furthermore, operational efficiency had an annual average increase of 33.74% and revealed a strong catch-up effect in terms of operational efficiency. The Western region was the only region where the star-rated hotels had an increasing TFP, technological progression, and operational efficiency simultaneously, and the growth rates were 11.65%, 6.37%, and 14.68%, respectively.

From the perspective of annual growth, we found that while the TFPs of the star-rated hotels in different regions had certain increases and their performances similarly plummeted in 2013, the growth rate of optimal production technology in the Western region markedly outperformed those in other regions and yet the growth rate of operational efficiency under-performed significantly. On the basis of the above analyses, we also found that the catch-up effects in the Central and Western regions were progressing in terms of operational efficiency and optimal production technology, respectively. From the perspective of competitiveness, while the competitiveness of the star-rated hotels in the Eastern region may be currently strong, that of the star-rated hotels in the Central and Western regions are improving, which is good news for the increase of TFP in the industry nationwide.

Finally, policy makers and practitioners should focus on TFP growth and its components, drawing attention to the importance of upgrading their optimal production technology and operational efficiency as a means of improving TFP and competitiveness in star-rated hotels.

Limitations and further research

There are limitations associated with our study to address. All of our findings were based on the sample and data we collected from the "CEIC China Database" from 2001 to 2015 in mainland China and therefore, the results and measures should be interpreted for star-rated hotels in the sample period only. However, our framework could be further employed not only to hotels in different countries but also other service sectors.

Future studies are encouraged to include more years of data, covering various economic conditions, to see how macro-environmental parameters may have impacted the TFP in the hotel industry. Besides, future studies may focus on TFP growth or changes among hotels of different types (e.g., mid- and up-scale) or star ratings (e.g., three to five-stars).

References

Aissa SB and Goaied M (2016) Determinants of Tunisian hotel profitability: The role of managerial efficiency. *Tourism Management* 52: 478-487.

Arbelo A, Pérez-Gómez P and Arbelo-Pérez M (2017) Cost efficiency and its determinants in the hotel industry. *Tourism Economics* 23(5): 1056-1068.

Assaf AG (2012) Benchmarking the Asia Pacific tourism industry: A Bayesian combination of DEA and stochastic frontier. *Tourism Management* 33(5): 1122-1127.

Assaf AG, Barros CP and Josiassen A (2010) Hotel efficiency: a bootstrapped metafrontier approach. *International Journal of Hospitality Management* 29(3): 468-475.

Assaf AG and Agbola FW (2011) Modelling the performance of Australian hotels: a DEA double bootstrap approach. *Tourism Economics* 17(1): 73-89.

Banker RD, Charnes A and Cooper WW (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science* 30(9): 1078-1092.

Barros CP (2004) A stochastic cost frontier in the Portuguese hotel industry. *Tourism Economics* 10(2): 177-192.

Barros CP (2005) Measuring efficiency in the hotel sector. *Annals of Tourism Research* 32(2): 456-477.

Barros CP (2006) Analysing the rate of technical change in the Portuguese hotel industry. *Tourism Economics* 12(3): 325-346.

Barros CP and Dieke PU (2008) Technical efficiency of African hotels. *International Journal of Hospitality Management* 27(3): 438-447.

Barros CP, Dieke PUC and Santos CM (2010) Heterogeneous technical efficiency of hotels in Luanda, Angola. *Tourism Economics* 16(1): 137-151.

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

Briec W and Kerstens K (2004) A Luenberger-Hicks-Moorsteen productivity indicator: its relation to the Hicks-Moorsteen productivity index and the Luenberger productivity indicator. *Economic Theory* 23(4): 925-939.

CEIC China Database (2016) Available at https://insights.ceicdata.com/insight/eea56f20-a312-4c8e-b5b2-3461800cae23/data (accessed 3 October, 2016).

Chambers RG and Chung Y (1998) Profit, directional distance functions, and nerlovian efficiency. *Journal of Optimization Theory & Applications* 98(2): 351-364.

Chan W (2012) Energy benchmarking in support of low carbon hotels: developments, challenges, and approaches in China. *International Journal of Hospitality Management* 31(4): 1130-1142.

Charnes A, Cooper WW and Rhodes E (1978) Measuring the efficiency of decision making units. *European Journal of Operational Research* 2(6): 429-444.

Chen CF (2007) Applying the stochastic frontier approach to measure hotel managerial efficiency in Taiwan. *Tourism Management* 28(3): 696-702.

Chen CF and Soo KT (2007) Cost structure and productivity growth of the Taiwanese international tourist hotels. *Tourism Management* 28(6): 1400-1407.

Chen MH (2007) Macro and non-macro explanatory factors of Chinese hotel stock returns. *International Journal of Hospitality Management* 26(4): 991-1004.

Chen MH (2010) The economy, tourism growth and corporate performance in the Taiwanese hotel industry. *Tourism Management* 31(5): 665-675.

Chen MH, Jang SS and Kim WG (2007). The impact of the SARS outbreak on Taiwanese hotel stock performance: an event-study approach. *International Journal of Hospitality Management* 26(1): 200-212.

Chen S (2009) Energy Consumption, CO2 Emission and Sustainable Development in Chinese Industry. *Economic Research Journal* 4(1): 41-55.

Chin JB, Wu MC and Hsieh LF (2013). Strategic planning of optimal resource allocation in response to global financial crisis – a study of international tourist hotels. *Applied Economics* 45(23): 3316-3328.

China National Tourism Administration (2016) The Yearbook of China Tourism Statistics. Beijing: China Travel & Tourism Press. Available at: http://www.cnta.gov.cn/zwgk/lysj/201601/t20160118 _758409.shtml (accessed 4 October, 2016).

Coelli TJ, Rao DSP, O'Donnell CJ and Battese GE (2005) An introduction to efficiency and productivity analysis. Springer Science & Business Media.

Cook D (1989) China's hotels: still playing catch-up. *Cornell Hotel and Restaurant Administration Quarterly* 30(3): 64-67.

Cordero JM and Tzeremes NG (2017) Evaluating hotel productivity growth in Balearic and Canary islands. *Tourism Economics* 23(5): 1146-1154.

Cracolici MF, Nijkamp P and Rietveld P (2008) Assessment of tourism competitiveness by analysing destination efficiency. *Tourism Economics* 14(2): 325-342.

Detotto C, Pulina M and Brida JG (2014) Assessing the productivity of the Italian hospitality sector: a post-WDEA pooled-truncated and spatial analysis. *Journal of Productivity Analysis* 42(2): 103-121.

Färe R, Grosskopf S, Lindgren B and Roos P (1994) Productivity developments in Swedish hospitals: a Malmquist output index approach. *In Data Envelopment analysis: theory, methodology, and applications (pp. 253-272)*. Springer Netherlands.

Farrell MJ (1957) The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)* 120(3): 253-290.

Fried HO, Lovell CAK and Schmidt SS (1993) The Measurement of Productive Efficiency: Techniques and Applications. New York: Oxford University Press.

Grifell-Tatjé E and Lovell CK (1995) A note on the Malmquist productivity index. *Economics letters* 47(2):169-175.

Huang CW (2017) Assessment of efficiency of manual and non-manual human resources for tourist hotel industry: An application of the hybrid DEA model. *International Journal of Contemporary Hospitality Management* 29(4): 1074-1095.

Huang Y, Mesak HI, Hsu MK and Qu H (2012) Dynamic efficiency assessment of the Chinese hotel industry. *Journal of Business Research* 65(1): 59-67.

Jang SS and Yu L (2002) Analysis of return on hotel investment: a comparison of commercial hotel companies and casino hotel companies. *Journal of Hospitality & Tourism Research* 26(1): 38-53.

Joo SJ, Stoeberl PA and Fitzer K (2009) Measuring and benchmarking the performance of coffee stores for retail operations. *Benchmarking: An International Journal* 16(6): 741-753.

Kerstens K and Van de Woestyne I (2014) Comparing Malmquist and Hicks–Moorsteen productivity indices: exploring the impact of unbalanced vs. balanced panel data. *European Journal of Operational Research* 233(3): 749-758.

Kilic H and Okumus F (2005) Factors influencing productivity in small island hotels: evidence from Northern Cyprus. *International Journal of Contemporary Hospitality Management* 17(4): 315-331.

Kim H, Gu Z and Mattila AS (2002) Hotel real estate investment trusts' risk features and beta determinants. *Journal of Hospitality & Tourism Research* 26(2): 138-154.

Kim S (2011) Factor determinants of total factor productivity growth in the Malaysian hotel industry: a stochastic frontier approach. *Cornell Hospitality Quarterly* 52(1): 35-47.

Lin YH (2011) Estimating cost efficiency and the technology gap ratio using the metafrontier approach for Taiwanese international tourist hotels. *Cornell Hospitality Quarterly* 52(3): 341-353.

Liu H, Tsai H and Wu J (2018) Regional hotel performance and benchmarking in the Pearl River delta: an input and output efficiency analysis. *International Journal of Contemporary Hospitality Management* DOI: https://doi.org/10.1108/IJCHM-05-2016-0270.

Liu H, Zhang Y, Zhu Q and Chu J (2017) Environmental efficiency of land transportation in china: a parallel slack-based measure for regional and temporal analysis. *Journal of Cleaner Production* 142: 867-876.

Luenberger DG (1992) New optimality principles for economic efficiency and equilibrium. *Journal of Optimization Theory & Applications* 75(2): 221-264.

Luo H, Yang Y and Law R (2014) How to achieve a high efficiency level of the hotel industry? *International Journal of Contemporary Hospitality Management* 26(8): 1140-1161.

National Bureau of Statistics of the People's Republic of China (2016) Available at: http://www.stats.gov.cn/tjsj/ndsj/ (accessed 3 Otc. 2016).

Nishimizu M and Page JM (1982) Total factor productivity growth, technological progress and technical efficiency change: dimensions of productivity change in Yugoslavia, 1965-78. *Economic Journal* 92(368): 920-936.

O'Donnell CJ (2010) Measuring and decomposing agricultural productivity and profitability change. *Australian Journal of Agricultural and Resource Economics* 54(4): 527-560.

O'Donnell CJ (2012) An aggregate quantity framework for measuring and decomposing productivity change. *Journal of Productivity Analysis* 38(3): 255-272.

Oliveira R, Pedro MI and Marques RC (2013) Efficiency and its determinants in Portuguese hotels in the Algarve. *Tourism Management* 36: 641-649.

Oses N, Gerrikagoitia JK and Alzua A (2016) Modelling and prediction of a destination's monthly average daily rate and occupancy rate based on hotel room prices offered online. *Tourism Economics* 22(6): 1380-1403.

Peng JJ and Chen H (2004) A Study on the Efficiency of Star-rated Hotels—a Case Study on the Relative Efficiency of Beijing, Shanghai and Guangzhou Province. *Tourism Tribune* 19(2): 59-62.

People.cn (2014) Available at: http://finance.people.com.cn/n/2014/0409/c1004-24857223.html (accessed 15 September, 2017).

Peypoch N and Solonandrasana B (2008) Aggregate efficiency and productivity analysis in the tourism industry. *Tourism Economics* 14(1): 45-56.

Peyrache A (2014) Hicks-Moorsteen versus Malmquist: a connection by means of a radial productivity index. *Journal of Productivity Analysis* 41(3): 435-442.

Phillips PA (1999) Performance measurement systems and hotels: a new conceptual framework. *International Journal of Hospitality Managemen*t 18(2): 171-182.

Pine R and Phillips P (2005) Performance comparisons of hotels in China. *International Journal of Hospitality Management* 24(1): 57-73.

Yasin MM, Czuchry AJ and Dorsch JJ (1997) A framework for the establishment of an optimal service quality level in a hospitality operational setting. *Journal of Hospitality & Leisure Marketing* 4(2): 25-48.

Rudež HN and Mihalič T (2007) Intellectual capital in the hotel industry: a case study from Slovenia. *International Journal of Hospitality Management* 26(1): 188-199.

Sigala M and Mylonakis J (2005) Developing a data envelopment analysis model for measuring and isolating the impact of contextual factors on hotel productivity. *International Journal of Business Performance Management* 7(2): 174-190.

Such Devesa MJ and Mendieta Peñalver LF (2013) Size, efficiency and productivity in the Spanish hotel industry–independent properties versus chain-affiliated hotels. *Tourism Economics* 19(4): 801-809.

Tsai H (2009) Star-rated hotel productivity in China: a provincial analysis using the DEA cross-efficiency evaluation approach. *Journal of China Tourism Research* 5(3): 243-258.

Tsai H, Wu J and Zhou Z (2011) Managing efficiency in international tourist hotels in Taipei using a DEA model with non-discretionary inputs. *Asia Pacific Journal of Tourism Research* 16(4): 417-432.

Tsang NKF and Hsu CHC (2011) Thirty years of research on tourism and hospitality management in china: a review and analysis of journal publications. *International Journal of Hospitality Management* 30(4): 886-896.

United Nations World Tourism Organization (2016) Available at: http://media.unwto.org/press-release/2016-05-03/exports-international-tourism-rise-4-2015 (accessed 4 Oct. 2016).

Witt CA and Witt SF (1989) Why productivity in the hotel sector is low. *International Journal of Contemporary Hospitality Management* 1(2): 28-36.

Wu CHJ and Liang RD (2009) Effect of experiential value on customer satisfaction with service encounters in luxury-hotel restaurants. *International Journal of Hospitality Management* 28(4): 586-593.

Xiao Q, O'Neill JW and Mattila AS (2012) The role of hotel owners: the influence of corporate strategies on hotel performance. *International Journal of Contemporary Hospitality Management* 24(1): 122-139.

Yin P, Tsai H and Wu J (2015) A hotel life cycle model based on bootstrap DEA efficiency: the case of international tourist hotels in Taipei. *International Journal of Contemporary Hospitality Management* 27(5): 918-937.

Yu MM and Chen LH (2016). Productivity growth of Taiwanese international tourist hotels in a metafrontier framework. *Cornell Hospitality Quarterly* 57(1): 38-50.

Yu X (2015) Environmental effects under china's western development strategy: a case study in the Beipan river basin, Guizhou. *International Journal of Environmental Studies* 72(1): 132-145.

Zha J and Li Z (2017) Drivers of tourism growth: evidence from China. *Tourism Economics* 23(5): 941–962.

Zhang HQ, Yan Q and Ye H (2008) A Comparative Analysis of the Mechanism of Policy Change in China's Travel Agency and Hotel Sectors: Journal of China *Tourism Research* 4(3-4): 229-247.

Zhao H (2014) *Comments on the top ten news of China's hotel industry in 2013. TravelDialy [Electronic version].* Avaialbe at: http://www.traveldaily.cn/article/76854 (accessed 21 October 2016).

Zhou Z, Huang Y and Hsu MK (2008) Using data envelopment analysis to evaluate efficiency: An exploratory study of the Chinese hotel industry. *Journal of Quality Assurance in Hospitality & Tourism* 9(3): 240-256.