Efficiency evaluation of hotel operations in Mainland China based on the Super-efficiency SBM model

Abstract

This research evaluated the efficiency of hotels in 31 provinces and four regions (Eastern, Western, Central, Northeastern China) using the super-efficiency slacks-based measure (SBM) model. The reasons for operational inefficiency were assessed from two perspectives: input redundancy and output shortfalls. Most hotels were found to have operational inefficiencies, and there is significant scope for future improvement. The relative efficiency of hotel operations by the four regions was the following: Eastern China > Central China > Western China > Northeastern China. The efficiency of hotels demonstrated differing coefficients of variation. The most significant coefficient of variation was for Western China, and the smallest was for Northeastern China. The primary cause of inefficiencies was in input redundancies, especially the high degree of input redundancy in number of hotels, employees and rooms. Also, to some degree, differences exist among the four regions in operational inefficiencies.

Keywords: Data envelopment analysis (DEA); efficiency; inefficiency; Super-efficiency SBM model; hotels; China

Introduction

In 1978, the Chinese government implemented the policy known as "Reform and Opening-up," which enhanced the prosperity of China's economy and the rapid development of its tourism sector (Gross & Huang, 2013). As an integral part and the principal income source of tourism, hotel development significantly progressed (Huang et al., 2012; Yang et al., 2015). Hotels became the foundation for local tourism economies and supported regional tourism development through providing the necessary accommodation, entertainment, catering, and meeting facilities (Yang & Wong, 2012). However, in recent years, the numbers of hotels, rooms, and employees, as well as the occupancy rates and operating revenues of the Chinese hotel industry have all declined to a certain extent. Compared with 2012, the number of hotels in China decreased by 13.2 percent (1,506 less) in 2016; the room supply fell by 5.1 percent (-76,699); hotel employees were down by 18.2 percent (-289,000); occupancy rates were 9.3 percent lower; and operating revenues decreased by 16.6 percent (-40.296 billion RMB). However, the investment in fixed assets increased by 40.699 billion RMB or 8.5 percent. The hotel industry in Mainland China began facing unprecedented challenges. On the one hand, this was due to the global economic slowdown. On the other hand, the Chinese government implemented strict thrift measures and imposed the "Eight Regulations" and "Six Bans" on "Three Public Consumptions", which led to less spending on rooms, food and beverages, and meetings. Apart from these external influences, perhaps more important were defects in the hotel development model in China. The utilization ratio of available resources was low (Tsai, 2009; Yu & Gu, 2005) and the operating efficiency of the hotel industry was at a low ebb. Efficiency is the relationship between input and output in operations. A decision-making unit (DMU) is considered as technically efficient if, from the basket of inputs it holds, it produces the maximum of outputs possible or if, to produce a given quantity of outputs it uses the smallest quantities possible of inputs (Atkinson & Cornwell, 1994; Yang, Xia, & Cheng, 2017). In an increasingly competitive market environment, a reliable evaluation system is a precondition for effective strategic decision-making and sustainable planning (Gross, Gao, & Huang, 2013; Luo, Yang, & Law, 2014; Yang, Xia, & Cheng, 2017). Consequently, it is an important and urgent issue for China to accurately measure and evaluate the efficiency of hotel operations, to explore the reasons for inefficiencies, to suggest possible optimal resource allocation, and to improve the competitiveness of China's hotels.

Differences among the regions within a country can cause imbalances in regional industrial economic development, and this also applies to the hotel industry. Regions have varying levels of economic development, different market demand volumes and labor costs, which affect hotel efficiency (Hu et al., 2017; Zhou, Huang, & Hsu, 2008). Parte-Esteban and Alberca-Oliver (2015) examined the efficiency of hotels in 17 Spanish autonomous regions and found that Madrid, the Basque Country, and Catalonia were the regions with the highest levels of efficiency. By contrast, the regions with the lowest levels of efficiency were Aragon, Castilla-Leon, and Murcia. Pulina et al. (2010) analyzed the efficiency of hotels in 20 regions of Italy and indicated that Sardinia could be considered as a region “falling further behind”, whereas some regions in the north and center of Italy could be regarded as “moving ahead.” Several Chinese scholars have compared the efficiency of starred hotels in Mainland China at the provincial level (Yang, Xia and Cheng, 2017; Zhang and Cheng, 2014), while others contrasted hotel efficiency across cities (Yi and Liang, 2015; Long, Li and Du, 2016). In fact, regional differences in hotel efficiencies in Mainland China have continually been the focus of scholars and government agencies. With Mainland China being in the initial stages of a market economy, the intervening role of government policy requires monitoring. For example, the "Western Development" initiative of the Central Government, including positioning the tourism sector as an economic pillar in Western China not only played a significant role in accelerating economic development, but also had a far-reaching impact on the development of hotels.

In the Data Envelopment Analysis (DEA) model, whether a DMU is efficient or not depends on the “slacks.” The slacks refer to the difference between the actual value of inputs and outputs and the optimal value on the corresponding production frontiers. When the difference is 0, it means that the DMU is efficient, that is, the efficiency score is equal to 1 (one). On the contrary, when the difference is not zero, the DMU is inefficient, that is, the efficiency score is less than one (1) (Tone, 2001). The slacks of inputs and outputs are measured in some previous research studies (Barros, 2005; Chiu et al., 2012; Cruz, 2017; Tsaur, 2000). For example, Chiu, Huang and Ting (2012) found excesses in employees, rooms, catering spaces and operating expenses, and shortfalls in occupancy rates, which were the root of inefficiency in most Taiwan hotels. By identifying the slacks in inputs and outputs of inefficient hotels and a peer group of efficient hotels, DEA can suggest improvements in operational efficiencies (Barros, 2005). Knowledge on slacks provides hotel owners and managers with valuable information about efficiency decision processes (Manasakis, 2013). It is important to note that a large slack does not mean that it contributes significantly to inefficiency.

The existing literature gives greater attention to hotel efficiency and slacks, and less emphasis to the analysis of hotel inefficiency. An inefficiency score is defined as the ratio of slacks to actual inputs or outputs. The larger the ratio, the greater its contribution to inefficiency. Charnes et al. (1985) explained all the sources of input and output inefficiency through the additive model. Inefficiency is divided into input and output inefficiencies. If input inefficiency is much greater than output inefficiency, input excesses are the source of inefficiency. If input inefficiency is far less than output inefficiency, output shortfalls are the cause of inefficiency. If the input inefficiency is not different from the output inefficiency, the input excesses and the output shortfalls are the causes of inefficiency. Input and output inefficiencies can also be analyzed on a total and individual basis. The total input inefficiency is equal to the average inefficiency of all individual inputs, and the total output inefficiency is equal to the inefficiency mean for all individual outputs. Technical inefficiency is the result of several factors working together (Barros and Alves, 2004). Only one study measuring hotel inefficiency was found in the existing literature, with Manasakis (2013) comparing the slacks and inefficiencies of independent and branded hotels in Crete, Greece, from the perspective of individual inputs and outputs. It was found that the inefficiencies of bed capacities and employees of independent hotels were higher than those of branded hotels, while the inefficiencies of operational costs and total revenues of branded hotels were higher than those of independent hotels.

The previous literature has made significant contributions to the research on hotel efficiency. However, there remain some research gaps and opportunities for further development of this topic. For China, research on hotel efficiency not only needs contemporary provincial comparisons, but also requires analysis of regional differences. Mainland China is commonly divided into four regions, based on geographical location along with social and economic factors. In 2017, the Chinese Government Work Report outlined the four regional development strategies of "*First development of Eastern China*", "*Development of Western China*", "*Revitalization of Northeast China*" and "*Rise of Central China*". The comparison of hotel efficiencies in these four regions has important practical significance. Manasakis (2013) studied hotel inefficiency, but only measured individual inputs and outputs, and not total input and total output inefficiency. The latter makes it clearer whether hotel inefficiency is due to input redundancies, output shortfalls, or both. In addition, Manasakis adopted the BCC radial model, but did not consider the non-radial model, or the combination of the non-radial model and the super-efficiency model to study hotel inefficiency. Huang (2016) expressed the opinion that the non-radial model not only considered the slacks, but also added the slacks to the objective function, which was more accurate than overestimating the efficiency score. More importantly, using super-efficient DEA could solve the ranking problem of the efficient DMU. There is minimal research on hotel efficiency that combines super-efficiency and non-radial models. Only Yang et al. (2017) used this method to measure the efficiency of starred hotels, but they did not consider input and output inefficiencies. In summary, the only study on hotel inefficiency did not use the non-radial model, and the only investigation applying the super-efficiency non-radial model to measure efficiency of hotels did not carry through to analyze hotel inefficiency. Therefore, there is still scope for study of hotel efficiency and inefficiency.

The objectives of this research were to compare the relative efficiency of starred hotels in 31 provinces and four regions in Mainland China; determine the causes of inefficiency; and provide suggestions and practical guidance for local governments and corporate managers to improve efficiency of hotels. The potential contribution of this work lies in three areas. First, the inefficiency of the hotel industry in Mainland China was analyzed from a multi-scale perspective. Although there is considerable previous research on hotel efficiency, so far there is an absence of investigation of hotel industry inefficiency in Mainland China, and there are no studies of hotel inefficiency at the provincial and regional levels. Second, hotel inefficiency is comprehensively interpreted; the root of hotel inefficiency was measured not only from individual input and output, but also from total input and output. Third, this research applied the non-radial model to measure hotel inefficiency for the first time.

Literature review

The concept and measures of efficiency are of great significance in economics and have been widely analyzed in various sectors. Hotels are no exception and the research on hotel efficiency mainly includes the measurement and ranking of efficiency and the factors influencing efficiency (Yang et al., 2017; Yi and Liang, 2015).

Measurement of hotel efficiency

The early methods of measuring hotel performance included cost-volume-profit indices (Coltman, 1978), lodging sales receipts (Van Doren and Gustke, 1982), lodging indices (Wassenaar and Stafford, 1991), and revenue performance indicators (Baker and Riley, 1994). However, these measures were not entirely effective, because they did not consider the multiple indexes of the hotel industry or their interactions (Anderson, Fok, & Scott, 2000; Barros & Dieke, 2008; Barros, Peypoch, & Solonandrasana, 2009). Recently, DEA and Stochastic Frontier Analysis (SFA) have incorporated a variety of inputs and outputs in the analysis of hotels, resulting in more comprehensive, accurate and easier-to-understand performance measurement standards (Arbelo-Pérez et al., 2017). Compared with SFA, DEA is more widely used, as it does not need to assume the function form. Morey and Dittman (1995) used DEA for the first time to measure the average management performance of 54 hotels in the United States, and Tsaur (2000) evaluated the operating efficiency of 53 hotels in Taiwan with DEA.

To clarify the efficiency structure and its contribution rate, several scholars have decomposed technical efficiency into pure technical efficiency and scale efficiency and discuss cost efficiency and allocative efficiency. For example, Andersen et al. (2000) assessed the allocative, technical, pure technical, and scale efficiencies of U.S. hotels. Barros and Mascarenhas (2005) analyzed the technical and allocative efficiencies of 43 small chain hotels in Portugal. Hu, Shieh, Huang, and Chiu (2009) used the two-stage DEA method to measure the cost, allocative, and overall technical efficiencies of 68 international tourism hotels in Taiwan from 1997 to 2006.

Because the Malmquist productivity index can depict the dynamic characteristics of efficiency, some scholars have introduced it into hotel analysis (Barros and Alves, 2004; Ferrera & Tzeremes, 2017; Hwang and Chang, 2003; Yi and Liang, 2015). Hwang and Chang (2003) used the Malmquist index to measure the changes in management efficiency of 45 hotels in Taiwan from 1994 to 1998. They found that the efficiency changes for 20 hotels were greater than 1 (one) and that of 25 hotels were less than 1 (one), meaning that the management efficiency of 20 hotels had improved in the past four years, while the efficiency of 25 hotels declined. Barros and Alves (2004) measured the total factor productivity and technical efficiency of 42 hotels in Portugal from 1999 to 2001. They concluded that the total factor productivity of most hotels declined, and the technical efficiency improved. Ferrera and Tzeremes (2017) evaluated hotel productivity in Spain's Balearic and Canary Islands from 2004 to 2013 and revealed that the economic downturn had major negative effects on hotel productivity for two years (2008 and 2009). After 2009, hotels increased their productivity levels driven by both technological and other innovations.

All the aforementioned studies applied the radial DEA model in the assessment of hotel operational efficiencies. They assumed that inputs or outputs changed with their proportions, ignoring the slacks that exist in efficiency. However, these assumptions do not conform with reality. Therefore, some scholars applied the non-radial DEA model proposed by Tone (2001) to study hotel efficiency (Ashrafi, 2013; Cheng, Lu, & Chung, 2010; Chiu, Huang, and Ting, 2012; Cruz, 2017; Sun and Lu, 2005; Untong, 2013; Wu, Tsai, & Zhou, 2011; Yang and Lu, 2006). For example, Chiu et al. (2012) compared the efficiency of 58 international tourism hotels in Taiwan with radial and non-radial models. Ashrafi (2013) used the non-radial DEA model known as the slacks-based measure (SBM) to identify the efficient years of the hotel industry in Singapore from 1995 to 2010, and then the efficient DMUs were ranked with the SBM model of super-efficiency. Untong (2013) adopted DEA with the slacks-based measure (SBM) and meta-frontier analysis to assess the operational efficiencies of Thailand’s hotels in Chiang Mai and Phuket. Cruz (2017) evaluated the efficiency of 10 deluxe hotels in Metro

Manila, Philippines using the slack-based and Malmquist productivity index models.

In addition, Modified DEA approaches have been employed to measure the efficiency of the hotel industry. For example, Hsieh et al. (2010) measured the productivity of a Paris hotel chain based on the relational network DEA. Pulina, Detotto, and Paba (2010) analyzed the technical and scale efficiencies of hotels in 20 regions of Italy using the window DEA method. Corne (2015) applied the hierarchical category DEA model to explore the efficiency of different types of hotels in France.

Factors affecting hotel efficiency

The differences in efficiency result from a series of factors (Barros & Dieke, 2008). Previous research has shown that there are significant differences in hotel efficiency due to location, size, star level, management style and customer satisfaction (Hwang and Chang, 2003; Yang and Lu, 2006). In a study of Italian tourism, Bernini and Guizzardi (2010) found a positive correlation between hotel location and technical efficiency, especially in cities by the beach or of recognized cultural importance. Pereira-Moliner, Claver-Cortés, and Molina-Azorín (2011) concluded that location was an important factor affecting performance, income and occupancy rate. Location has a positive impact on hotel prices (Hung et al., 2010). Hotels in popular tourist spots had higher RevPARs (revenue per available room) (Sainaghi, 2011).

Lin (2011) analyzed the cost efficiency of 62 international tourism hotels in Taiwan from 2002 to 2006 with the Meta-frontier model. He found that small-scale hotels were more efficient than large-scale ones, and the cost efficiency of domestic chain hotel was higher than that of independent hotels while the efficiency of independent hotels was higher than that of international hotel chains. Fernández et al. (2015) suggested that large hotels were more efficient than small properties after measuring the operational efficiency of Spanish hotel chain groups, and resort hotels were more efficient than other types of hotels. Also, quality had a significant negative impact on efficiency. Arbelo-Pérez et al. (2017) argued that quality had a negative impact on hotel cost efficiency and positive effect on profit efficiency. Interestingly however, some authors have found a strong positive correlation between quality and efficiency (Brown and Ragsdale, 2002). Oliveira (2013) measured the efficiency of Portuguese hotels in Algarve and found that hotel stars were not a significant factor in efficiency, but the location and presence of a golf course were correlated with efficiency. Poldrugovac et al. (2016) analyzed 105 Croatian hotels using the variance method. It was found that there was a statistically significant relationship between scale and efficiency, while there was no statistically significant relationship between star level and efficiency.

Assaf and Magnini (2012) examined the role of client satisfaction on the efficiency of U.S. hotel chains and found that satisfaction had an important positive effect on efficiency level. Because satisfaction is related to loyalty, it can reduce transaction costs and price elasticity in the future bookings. Zaman et al. (2016) discovered that satisfaction was inversely proportional to the efficiency of hotels.

In addition to exploring the factors affecting hotel efficiency from a micro-level, scholars have analyzed the concept from the macro-level. Chen and Chang (2013) found that the market concentration index (denoted as the Herfindahl-Hirschman Index or HHI) had significant positive effects on chain and independent hotels in Taiwan. According to Hu et al. (2017), the degree of marketization, level of information and scale of tourism had a significant positive impact on the efficiencies of starred hotels, and they constructed an efficiency driving mechanism. Zhang (2017) concluded that economic development level, number of tourists, industrial structure, and regional openness had significant positive effects on the improvement of the technological efficiency of starred hotels in Mainland China. Tourism income and population urbanization had negative effects. Sun (2014) suggested that economic development and traffic accessibility promote the efficiency of a hotel industry to a certain extent. Significant regional tourism attractions are related to superior hotel performance (Barros et al., 2011). Yang et al. (2017) incorporated external factors into hotel input variables and found that regional tourism attractions, foreign direct investment (FDI), gross domestic product (GDP), retail sales, Internet domains, green area ratio, air passengers, and destination openness had important impacts on hotel efficiency in Mainland China.

Study methods and variable choice

Study methods

Data envelopment analysis (DEA) is a linear programming method for measuring the relative efficiency of DMUs and constructing production frontiers with several inputs and outputs. The most basic models of DEA are CCR and BCC. Since the CCR and BCC models do not take into consideration the effect of slacks of inputs and outputs on the reliability of model estimation, their efficiency evaluations have significant deviations. Tone (2001) recommended employing the SBM model based on the slacks to evaluate the relative efficiency of DMUs. Suppose there are n DMUs, each DMU has m input and s output, represented as input vector x and output vector y. The general expression of the SBM model based on variable returns to scale is:

$$\rho^* = min\rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_{i0}}}{1 + \frac{1}{s}\sum_{r=1}^{s}\frac{s_r^+}{y_{r0}}}$$

$$\begin{aligned} \text{s.t.} \quad & x_{i0} = \sum_{j=1}^{n}\lambda_j x_{ij} + s_i^- \qquad i = 1,2,\cdots,m \\ & y_{r0} = \sum_{j=1}^{n}\lambda_j y_{rj} - s_r^+ \qquad r = 1,2,\cdots,s \qquad (1) \\ & s^- \geq 0,\ s^+ \geq 0 \\ & \lambda \geq 0 \text{且} \sum_{j=1,\neq 0}^{n}\lambda_i = 1 \end{aligned}$$

In the formula (1), s^- and s^+ represent the slack vector of inputs and outputs; λ is a weight vector; x_{ij} and y_{rj} are respectively the input and output of the j DMU; x_{i0} and y_{r0} are the input and output of the evaluated DMU. The optimal value ρ^* is the efficiency of SBM, $0 \leq \rho^* \leq 1$. When $\rho^* = 1$, namely $s^- = s^+ = 0$, meaning the DMU is efficient, and $0 \leq \rho^* < 1$, indicating the DMU is inefficient.

However, in an empirical analysis, there may be more than one efficient DMU, and the SBM model cannot sort them and is unable to compare and distinguish the efficient units. To overcome this shortcoming, Tone (2002) suggested the super-efficiency SBM model and explained that its basic principle was excluding the DMU from the new production possibility set of DMUs before evaluating that unit. Regarding an inefficient DMU, since its production frontier would not change, its efficiency value will be the same one with that of the SBM model. For an SBM efficient DMU, owing to the recalculation and changes of production frontier, its efficiency value would be more than one (1). Also, considering that hotel operations are complicated systems, they cannot be analyzed from the perspective of individual inputs and outputs (Hou et al., 2015). So, the non-angular super-efficient SBM model was chosen and its expression was:

$$\delta^* = \min\delta = \frac{(1/m)\sum_{i=1}^{m}\bar{x}_i/x_{i0}}{(1/s)\sum_{r=1}^{s}\bar{y}_r/y_{r0}}$$

$$\text{s.t.}\ \ \bar{x} \geq \sum_{j=1,\neq 0}^{n}\lambda_j x_j$$

$$\bar{y} \leq \sum_{j=1,\neq 0}^{n}\lambda_j y_j \qquad (2)$$

$$\bar{x} \geq 0,\ \ \bar{y} \leq y_0$$

$$\bar{y} \geq 0,\ \ \lambda \geq 0 \text{且} \sum_{j=1,\neq 0}^{n}\lambda_i = 1$$

In formula (2), $\bar{x}$ and $\bar{y}$ are the input and output vectors in the new production possibility set $\bar{P}$ besides (x_0, y_0), namely $(x_0, y_0) \in \bar{P} \setminus (x_0, y_0)$, $\delta^*$is the efficiency value of super-efficiency SBM. The meaning of the other variables is the same as in formula (1).

Variable choice and data sources

According to data availability, the factors chosen were number of hotels and guest rooms, amount of fixed capital stock, and number of employees as inputs; occupancy rates and operating revenues were the outputs. The definitions of inputs and outputs follow, and the descriptive statistics of the data are in Table 1.

The number of hotels (x1) was the total number of hotels in each DMU.

The number of rooms (x2) was the total number of rooms in each DMU (Anderson et al., 1999; Brown & Ragsdale, 2002; Chiu et al., 2012). The number of hotels and rooms was related to the construction intensity of hotels in DMUs, reflecting the input of hotel industry material capital.

Fixed capital stock (FCS) (x3) reflected the effect of fixed asset investment on the business scale and operational ability of the hotel sector (Martínez-Ross & Orfila-Sintes, 2012). Since fixed-asset investment not only affects performance in the current period but also in the future, it is necessary to calculate the amount of fixed capital (Kohli, 1982; Wu, 2014). Its computational formula was:

$$K_t = I_t/P_t + (1 - \delta_t)K_{t-1},\ K_0 = I_0/(g + \delta) \qquad (3)$$

In formula (3): K_t and K_{t-1} respectively are the fixed capital stock in the t and t-1 phase and I_t is the total amount of fixed capital investment in the t phase. P_t is the price indicator for fixed capital investment, δ_t is the discount rate in the t phase, which is generally 5%. K_0 is the capital amount in the base period, and I_0 is the investment amount of fixed capital in the base period.

The number of employees (x4) refers to the number of employees taking part in hotel operations, involving guest rooms, catering, and service and management personnel in other departments (Chiu et al., 2012). This labor pool reflects the human investment in hotels (Anderson et al., 1999; Barros, 2005; Barros and Mascarenhas, 2005; Manasakis et al., 2013).

The occupancy rate (y1) is the proportion of the number of guest rooms rented to the available number of guest rooms (Chiu et al., 2012; Corne, 2015; Zhou et al., 2008).

Operating revenues (y2) are the overall operating revenues of a hotel (Chiu et al., 2012; Huang et al., 2017), containing income from rooms, catering, and other sources. To account for inflation in operating income, revenues were discounted based on the unchanged price indicator in 2006 (the base period).

The data used for the input and output factors were taken from ten annual issues of the Yearbook of China Tourism Statistics from 2007 to 2017. Starred hotels studied in this research included domestic-funded enterprises, Hong Kong, Macao, Taiwan-funded enterprises and foreign-funded enterprises in terms of economic types.

[Insert Table 1 about here]

Empirical results

Efficiency evaluation in different provinces and municipalities

According to the research of Tone (2002), the super-efficiency SBM model in formula (2) was used to evaluate the operational efficiency of hotels across 31 provinces and municipalities in Mainland China from 2006 to 2016, and then ranked them according to the annual average (Table 2). The efficiency of provincial hotels in Mainland China fluctuated; in 2006-2011 there was an upward movement, while 2012-2016 experienced a downward trend. The efficiency of the hotel industry was influenced by China's domestic policies and domestic and foreign economic factors. From 2006 to 2016, the operational efficiencies of hotels in Beijing, Shanghai, Zhejiang, Hunan, Qinghai, and Ningxia were higher than 1 (one), which meant their operations were efficient. Apart from earlier years, the operational efficiencies of hotels in Tianjin, Guizhou, Hainan and Tibet were more than one (1), while that of hotels in Shanxi was more than one (1) except for 2014 and 2016. The hotel operational efficiencies in Hebei, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Jiangsu, Fujian, Hubei, Guangdong, Guangxi, Sichuan, Yunnan, Shaanxi, Gansu, and Xinjiang were less than one (1) throughout the years, so they were regarded as inefficient. However, among them, the hotels in Jilin, Heilongjiang, Hubei, and Sichuan demonstrated an improving trend.

From the perspective of super-efficiency average, Shanghai, Ningxia, Qinghai, Zhejiang, Beijing, Tianjin, Hunan, Tibet and Shanxi ranked in the top places for efficient hotels. This may be partially explained by location, with Shanghai, Beijing, and Tianjin situated in Eastern China, which were the first to implement “Reform and Opening-up” and now have the most developed economies. Shanghai, as a strategically located city, has distinct advantages in many aspects such as commerce, trade, transportation, tourism, conventions and exhibitions, and shopping. Beijing, the capital of China, has abundant cultural-heritage resources, as well as an exceptional tourism development environment (Yang et al., 2015). Tianjin is an integral part of the Beijing-Tianjin-Hebei region, and its coastal new region is known as "China's third pole of economic growth." Hunan is in Central China, and Changsha, Zhuzhou, and Xiangtan are its principal cities. Shanxi is known as the "Ancient Museum of China". The total number of ground cultural relics ranks first in China. The matching of input and output factors of hotels is relatively good. Tibet, Qinghai, and Ningxia are in Western China, where generally economic development and basic infrastructure construction are less advanced. However, they have unique tourism attractions, such as Tibet's Potala Palace, Qinghai Lake, Ningxia Hui folk customs, which have increased occupancies, raised operating revenues, and reduced seasonality, and relatively low hotel investment costs, and demand often exceeds supply in peak tourism seasons. From the perspective of the theoretical model, hotel operational efficiency reflects the relationship between inputs and outputs. Efficiencies also mirror coordination between hotels and local resources and conditions. Lower scores were recorded for Hebei, Guangxi, Sichuan, Shaanxi, Liaoning, Heilongjiang, Gansu, and Yunnan. Some provinces like Guangxi, Yunnan, and Sichuan have rich tourism resources, while others such as Hebei and Liaoning have fewer tourism attractions. Apart from input excesses and output shortfalls, the inefficiencies of hotels in these provinces were partly attributable to the structural relationship between the overall development of hotels and local economic development (including business, exhibitions, and shopping) as well as local construction status (transportation conditions, city construction) (Yang et al., 2015). For example, in 2016, Yunnan Province had 559 hotels and 56,632 rooms, ranking first in the west, the country's forefront, but the level economic development lagged behind, per capita GDP in the Western China with 12 provinces is only higher than Guizhou, highway and high-speed rail construction is relatively backward.

[Insert Table 2 about here]

Comparison of hotel efficiency in four regions

According to previous research (Hu, Mei, & Wei, 2017; Xie et al., 2012), China was divided into four regions - Eastern, Central, Western, and Northeastern China. Eastern China is composed of Beijing, Fujian, Guangdong, Hebei, Jiangsu, Shandong, Shanghai, Tianjin, Zhejiang. Central China comprises of Anhui, Henan, Hunan, Jiangxi, Shanxi, and Hubei. Western China includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Hainan, Ningxia, and Xinjiang. Northeastern China contains Heilongjiang, Jilin, and Liaoning.

The hotel operational efficiencies in these four areas were analyzed and compared (Table 3). The highest hotel operational efficiencies were in the Eastern provinces and cities. Next were the hotels in Central and Western provinces and cities, and last was the Northeastern provinces. The average efficiency values in these four areas were 0.844, 0.817, 0.755 and 0.480, and the coefficient of variation (CV) had a wavelike rising trend (Figure 1).

The principal reason behind this finding was the relatively more advanced economies of

Eastern China. In 2016, the region's GDP reached 41.02 trillion RMB, representing 55.12% of the national total. The developed economies provide a comparatively complete macro-environment for the development of hotels, giving them more capacity to utilize and transform the surrounding resources (Sun, 2012), and the ability to attain a relatively high level of operational efficiency. The business environment, coupled with meeting and exhibition activity, has a close relationship with the operational efficiency of hotels. Favorable business environments and high levels of meetings and events promote population mobility, enhance the prosperity of logistics and information communication, and play a significant role in the development of the hotel industry (Yang et al., 2015). Moreover, in Eastern China, especially within the Yangtze River Delta, Pearl River Delta, and Bohai Rim, hotels developed at an early stage with high standards and rapidly developed. Most hotel chains and well-known brands are concentrated in this area. Nevertheless, there was a significant difference among hotels in Eastern China, with the average coefficient of variation being 0.342, second only to Western China. Shanghai, Zhejiang, Beijing and Tianjin had the highest efficiencies, ranking second, third, fifth and seventh respectively, and Guangdong (18th), Jiangsu (19th) and Hebei (26th) were the most inefficient.

The efficiency of hotel industry in Central China was second only to Eastern China, but it was declining, especially in 2015 and 2016. The main reason was Central China's continuing dependence on extensive capital input for economic growth, and increases in occupancy rates relied on capital investment. Moreover, the growth of tourism was slow, and the addition of hotels was too rapid, leading to large capital stocks. In 2016, the average capital stock of hotels in all provinces in Central China reached 71.609 billion RMB, which to some degree constrained the utilization efficiency of capital and improvement of industrial profits (Wan et al., 2007). The average coefficient of variation among provinces in Central China was 0.260, which was relatively low when compared with the Eastern and Western regions. There were differences among the Central provinces. Hotels in Hunan remained efficient throughout the period, while hotels in Shanxi were efficient in most years, and Henan, Anhui, and Jiangxi only were efficient at times, and Hubei hotels continuously displayed inefficiency.

The hotels in Western China developed at a later stage from a lower standard starting point, yet achieved rapid development and improvement. This may be the result of significant tourism demand growth in Western China, fueling the development of tourism, and attracting many hotel openings and further advancements in the development of the regional hotel industry (Yang et al., 2015). The second reason is the effect of the Central Government's policy of "Western Development." This initiative made China's West the new region for attracting the attention of investors, giving it an outstanding 'later-mover' advantage. In the last ten years, hotel development, capital injections, and infrastructure construction in Western China have significantly expanded. For instance, in 2016, the fixed asset investment in Western China reached 1059.97 billion RMB, representing 20.48% of the national investment total, and ranking second. Additionally, the strategic position attached to tourism also played a role in the development of hotels. All twelve provinces in Western China accorded a high priority to the development of tourism as a leading economic sector (Wang, 2013). The high status given to tourism propelled the rapid improvement of hotel operational efficiencies. Again, however, there were significant differences among Western provinces, and the average coefficient of variation of hotel operational efficiency was 0.393. The highest operational efficiencies were for Qinghai, Ningxia, and Tibet; the remaining areas were inefficient.

Hotel operational efficiencies in Northeast China were the lowest. As a critical heavy industry base of China, the Northeast has a single industrial structure. Tourism and hotels developed at a later stage and did not grow rapidly. Hotel standards were not at their highest, with few famous hotel brands and groups locating here. Also, because of a lack of hotel management expertise and management technology (Zhang, 2014), hotel operational efficiencies have always been at a low level. The hotel operation efficiencies in Jilin, Liaoning and Heilongjiang were less than one (1). Their national rankings were 24th, 30th, and 31st respectively. Northeast China suffered from input redundancies and output shortfalls. The internal differences in Northeastern China were not great, and the coefficient of variation was 0.062.

[Insert Table 3 about here]

[Insert Figure 1 about here]

Analysis of the inefficiency of hotels

The SBM model in formula (1) measured and estimated the operational efficiency of hotels in all provinces and municipalities in Mainland China, and found most of the hotels in China were in an inefficient state. Were either the input redundancies or output shortfalls the reason for the inefficiency of hotels across China or did both play a part? What were the proportions of real input and output in the input redundancies and output shortfalls?

To answer these questions, performance in 2011 and 2016, which represents the initial stage of China's "12th Five-Year "and "13th Five-Year Plan", was taken as an example, exploring the principal reasons for hotel operational inefficiencies from the perspectives of total input inefficiency, individual input inefficiency, total output inefficiency, and individual output inefficiency.

Considering that input redundancies and output shortfalls of inefficient DMUs are measured based on slacks (Huang et al., 2017), this research defined input inefficiency as the proportion of input slacks to the real input, and the output inefficiency as the proportion of output slacks to the real output. The computational formula was as follows:

$$Iineff_i = s_i^- / x_{i0} \quad (4)$$

$$Oineff_r = s_r^+ / y_{r0} \quad (5)$$

$$\text{Iineff} = (1/m) \sum_{i=1}^{m} (s_i^- / x_{i0}) \quad (6)$$

$$\text{Oineff} = (1/s) \sum_{r=1}^{s} (s_r^+ / y_{r0}) \quad (7)$$

In the above formula, $Iineff_i$, $Oineff$, Iineff, Oineff represent the inefficiency of i input, the inefficiency of r output, the inefficiency of total input and the inefficiency of total output. s_i^-, s_r^+ respectively mean the i input and r output slacks, and $s_i^- \geq 0$, $s_r^+ \geq 0$, are the same as in formula (1).

From Table 2, China's inefficient provinces in 2011 and 2016 were 20, accounting for 64.5% of the total DMUs. According to formulas (4) - (7), inefficiency of total input, inefficiency of individual inputs, inefficiency of total output, and inefficiency of individual outputs (Table 4-5) were calculated for China's 20 provinces with inefficient hotels.

[Insert Table 4 about here]

[Insert Table 5 about here]

* $Iineff_1$, $Iineff_2$, $Iineff_3$, $Iineff_4$, Iineff stand for inefficiency in the number of hotels, inefficiency in the number of rooms, inefficiency in fixed capital stock, inefficiency of employees, and inefficiency in total input; $Oineff_1$, $Oineff_2$, Oineff presents the inefficiency in occupancy rates, the inefficiency in operating revenues, and inefficiency in total output.

From Table 4 and 5, the total input inefficiency in provinces with inefficient hotels in 2011 and 2016 were 0.349 and 0.461 respectively, and the total output inefficiency were 0.02 and 0.066 respectively. If total inputs were reduced on average by 34.9% and 46.1% respectively and total outputs increased on average by 2% and 6.6% respectively, all these provinces could reach relatively efficient levels. Total input inefficiencies in the two years were 17 and 7 times of total output inefficiencies respectively, which means that input redundancies were the main reasons for the inefficiency of hotels. Compared with 2011, total input and total output inefficiency of China's hotels in 2016 increased by 5.7% and 27% respectively.

In terms of the individual inputs, the inefficiency averages in 2011 and 2016 were in ascending order from fixed capitals stock (0.237 and 0.242), number of rooms (0.368 and 0.464), number of employees (0.393 and 0.502) to the number of hotels (0.398 and 0.636) respectively, showing that inefficiency from the number of hotels, employees, and rooms played a significant part in the input redundancies. This situation implied that hotel construction in these provinces only had emphasized increasing the number of properties, rather than improving quality, and showed they were still in a development phase of extensive investment and non-group management. In 2011, the inefficiency of the individual inputs of hotels in the 20 provinces was less than 0.7, but by 2016, that of the hotels in Hebei, Shandong, Anhui, Jiangxi, Hubei, Guangxi, Yunnan, Gansu and Xinjiang was greater than 0.7. The inefficiency because of the number of employees in Guangxi and Shaanxi was more than 0.7, indicating a relatively serious input redundancy.

Analyzing individual outputs, in 2011, the average of operating revenue inefficiency (0.032) of 20 inefficient provinces in Mainland China was higher than that of occupancy rate inefficiency (0.008), while in 2016 it was lower (0.043) than occupancy rate inefficiency (0.09). It indicated that inefficiency of operating revenues contributed more to total output inefficiency in 2011, and occupancy rate in 2016 contributed more to inefficiency of total output. The inefficiency of occupancy rate and operating revenues was related not only to the location, service quality, management type, average room rate, but also to the level of local development, the environment and the degree of openness. Compared with the inefficiency of individual input, the inefficiency of individual output was very small. However, the inefficiency of individual output in 2016 increased to a certain extent, suggesting that this trend should not be neglected in the inefficient provinces of Mainland China, and that improvements and adjustments are needed in the future. For instance, there was no output shortage for operating revenues in Jilin, but by 2016, its inefficiency was 0.641, ranking first for the inefficiency of individual outputs.

Both Tables 4 and 5 show that the inefficiency of total input of hotels in the four regions of China is much higher than that of the total output, indicating that the redundancy of total input was the important reason for the inefficiency of the hotel industry. In 2011, the total input inefficiency of the four regions was, in ascending order, from Western China, Central

China, Eastern China to Northeast China. Significant changes occurred in 2016, with the first and fourth places being reversed. Northeast China was the least inefficient region, while Western China was the most inefficient region. Mainland China has been undergoing "Supply-Side Reform" in recent years involving the adjustment of its economic structure, optimal allocation of elements and the improvement of the quality and quantity of economic growth. In 2016, the number of hotel employees in the Northeast was 63,200, down by 39,700 in 2011, while the Western region saw an increase of 7,700. The changes in Western China were closely related to increases in hotel inefficiency in Guangxi, Shaanxi and other provinces, while the inefficiency decrease in Northeast China was due to a significant reduction of the hotel inefficiency in Jilin. In terms of individual inputs, from 2011 or 2016, the number of employees, hotels, and rooms contributed most to the inefficiency of the hotels in Eastern China, Central China, and Western China. Hotel inefficiency in Northeast China was mainly affected by the number of hotels and the stock of fixed capital. Compared with 2011, the number of employees, hotels, and rooms grew in Eastern, Central, and Western China in 2016, while the number of hotels and fixed capital stocks in the Northeast declined. This explains to some extent why the total inefficiency of hotels in Northeast China fell. In terms of individual outputs, hotel occupancy rates in Eastern China (0.143) and operating revenues in Northeast China (0.214) were greater than 0.1 in 2016. Otherwise, the individual outputs of hotels in the four regions were very small and some were zero.

Conclusions

Applying the Super-efficiency SBM model, this research evaluated the operational efficiency of star-rated hotels in Mainland China from 2006 to 2016, and the main conclusions are listed below:

(1) The efficiency of provincial hotels in Mainland China showed a downward trend. From 2006 to 2016, the average efficiency of star-rated hotels in Mainland China was 0.769, and this could be improved by 23.1%. The provinces with an efficiency of more than one (1) throughout this period included Beijing, Shanghai, Zhejiang, Hunan, Qinghai, and Ningxia. The average efficiency in hotels was greater than one (1) in Beijing, Tianjin, Shanxi, Shanghai, Zhejiang, Hunan, Tibet, Qinghai, and Ningxia, showing most provinces' hotels were inefficient. This was consistent with the existing domestic scholars' conclusions, but the efficient DMU was not entirely the same. The possible reason was that the selection of research period was different (Hu, Mei, and Wei, 2017; Zhang & Cheng, 2014), or the construction of input and output indicators was different (Yang, Xia, Zhong, and Hu, 2015), or the research methods were different (Zhang & Cheng, 2014). The CCR model and BCC model were adopted in most domestic research, and the super-efficient SBM model was adopted in this analysis, which considered the non-proportional variation of factors and ranking.

(2) The overall efficiency of hotels in China showed the relationship of Eastern China > Central China > Western China > Northeast China. This was in accordance with Hu et.al (2017)'s viewpoint, but there were some differences with the results of Zhang et al.(2014), that was, the rank of hotel efficiency in Central China and Western China was just the opposite. This might be related to the choice of methods and research periods. Concerning different regions, the coefficients of variation of the efficiency in hotels varied. The

coefficient of variation in Western China was the highest, and then in order were Eastern, Central, and Northeastern China.

(3) There were 20 provinces in a state of hotel inefficiency in 2011 and 2016. This was the result of input redundancies. Regarding the input structure, fixed capital stock had a relatively low level of redundancy, but the input redundancy of the number of hotels, employees, and rooms was high, especially in 2016. The output inefficiency of occupancy rate and operating revenues was very small. Relatively speaking, in 2011, the inefficiency of hotel revenues was greater than the inefficiency of occupancy, in 2016, just the opposite.

(4) The total input inefficiency was the main source of hotel inefficiency in the four regions in Mainland China, and was in ascending order from Western China, Central China, Eastern China to Northeastern China in 2011, and was from Northeastern China, Central China, Eastern China to Western China in 2016. Total output inefficiency in 2011 and 2016 was very small. The individual input inefficiency of hotels in Eastern, Central, and Western China primarily resulted from the number of employees, hotels and rooms; in Northeastern China, it was from the number of hotels and the fixed capital stock. The individual output inefficient in the four regions was very small and was 0 in some areas.

This analysis shows that the redundancy of total input was a major contributor to hotel industry improvement in the inefficient provinces and regions, and the inefficiency scores for individual inputs was a main force in this adjustment. From the point of view of management, the greater the inefficiency, the lower is the utilization of resources and the more serious is the waste of resources. Conversely, the less the inefficiency, the less the adjustment is required for efficiency improvement (Manasakis et al., 2013).

The efficiency of hotels in the inefficient provinces of Mainland China can be improved through operational and strategic changes. At the operational level, input and output redundancies must be adjusted. Barros (2005) suggested that "adjusting the input and output of inefficient hotels is to enable these inefficient hotels to reach the efficient frontier.” The priority recommendation from this research is to adjust input redundancy. Table 5 shows that the number of hotels in Jilin in Northeast China is excessive. The number of hotels, rooms, and employees in Hebei, Jiangsu, Fujian, Shandong, and Guangdong in Eastern China; Anhui and Hubei in Central China; Inner Mongolia, Guangxi, Chongqing, Yunnan, Gansu, and Xinjiang in Western China were above what was required. The number of hotels, rooms, fixed capital stock, and employees in Jiangxi in Central China; Sichuan and Shaanxi in Western China; and Liaoning and Heilongjiang in Northeast China were also excessive. For overbuilt provinces, tighter controls on the construction of new hotels are needed, especially in Hebei, Shandong, Anhui, Jiangxi, Hubei, Guangxi, Yunnan, Gansu, and Xinjiang. Moderate adjustments need to be made in the excessive numbers of rooms and employees in Hebei, Jiangsu, Fujian, Shandong, Guangdong, Anhui, Jiangxi, Hubei, Inner Mongolia, Guangxi, Chongqing, Sichuan, Yunnan, Shaanxi, Gansu, Xinjiang, Liaoning, and Heilongjiang. The redundancy amounts and input directions of Jiangxi, Sichuan, Shaanxi, Liaoning and Heilongjiang in gross fixed capital formation require adjustment. In addition, the operating revenues of Jilin hotels were insufficient. Therefore, developing special tourism experiences (such as skiing) and hotel theme products are needed to increase guest volumes.

For the longer term, hotel group-driven branding and intensive development strategies should be implemented. The reorganization of hotel assets and the reform of property rights to set up several competitive hotel brand groups will help to solve many of the major existing practical problems. These groups will not only effectively solve the problem of input redundancy, but also optimize input structures and improve factor utilization ratios. Previous research confirms that hotel groups have greater efficiency than independent hotels (Chen, 2007; Hu, Chiu, Shieh, and Huang, 2010; Huang et al., 2016; Hwang and Chang, 2003; Manasakis et al., 2013; Wang, Hung, & Shang, 2006). Barros et al. (2011) found that M&A (mergers and acquisition) strategies were closely related with superior hotel performance. The China Tourism Group, a large tourism backbone enterprise managed by the Central Government, has ranked first in China's top 20 tourism enterprises for six consecutive years. The HK-CTS (Hong Kong China Travel Service) hotel company, an integral part of China Tourism Group, is engaged in the tourism and accommodation industry. The efficiency of hotels of HK-CTS and the competitive power have been enhanced with the acquisition of Kew Green, the UK's second-largest third-party management company.

Additionally, many hotels in China need to formulate and implement better and more professional talent strategies. Cultivating more hotel management talent should be a priority for the inefficient provinces. At present, there is significant turnover rates of Chinese hotel managers who, if they have proven performance, have high mobility. The establishment of effective talent training programs and superior incentive mechanisms are other initiatives that inefficient provinces must activate. Correspondingly, hotels must strengthen their human capital and further enhance managers' professional, decision-making, and communication abilities through training and contact with best practice hotel management. Professional hotel managers and supervisors should be attracted and retained with good compensation packages and strong and explicit corporate cultures.

The strategic implementation of a theme hotel product development strategy should be contemplated. Globally, the competition in the hotel industry is becoming fiercer; however, hotel products tend to be similar and the degree of differentiation is declining. Themed hotel products are a way to enhance differentiation and through this to improve the competitiveness and efficiency of hotels. Shanghai and Beijing are two municipalities directly under the Central Government, which are in the forefront of hotel industry efficiency in Mainland China. They have used their locational advantages to develop hotel products in the form of convention-exhibition hotels, boutique hotels, hotel apartments, resort hotels and others, to meet the needs of the market and guests, and thus have improved hotel occupancy rates, operating revenues, and efficiency.

There are some limitations to this research, such as the lack of a micro-level measurement, including studying individual hotels in specific cities with more fine-grained scales. Hotels generally include several different departments, and, in the future, it will be worthwhile to compare efficiency differences among departments by further subdividing their input and output variables. The China Tourism Statistics Yearbook divides Chinese Mainland hotels into domestic and foreign hotels. How efficient are these two types of hotels? If their efficiencies are significantly different, what are the causes? These are additional directions for future research. Also, comparing the efficiency and inefficiency of starred hotel under different models, such as super-efficient non-radial model and radial model is another research opportunity.

References

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

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

Arbelo-Pérez M, Arbelo A and Pérez-Gómez P (2017) Impact of quality on estimations of hotel efficiency. *Tourism Management* 61(3): 200-208.

Assaf A and Magnini B (2012) Accounting for consumer satisfaction in measuring hotel efficiency: evidence from the US Hotel industry. *International Journal of Hospitality Management* 31 (3): 642-647.

Ashrafi A, Seow HV, Lee LS and Lee CG (2013) The efficiency of the hotel industry in Singapore. *Tourism Management* 37(1): 31–34.

Atkinson S and Cornwell C (1994) Parametric estimation of technical and allocative inefficiency with panel data. *International Economic Review* 35(1): 231-244.

Avkiran NK (2006) Productivity Analysis in the services sector with Data Envelopment Analysis. Available at SSRN: http://dx.doi.org/10.2139/ssrn.2627576

Baker M and Riley M (1994) New perspectives on productivity in hotels: some advances and new directions. *International Journal of Hospitality Management* 13(4):297-311.

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

Barros CP (2005) Evaluation the efficiency of a small hotel chain with a Malmquist productivity index. *International Journal of Tourism Research* 7(3): 173–184.

Barros CP and Alves FP (2004) Productivity in the tourism industry. *International Advances in Economic Research* 10(3): 215–225.

Barros CP, Botti L, Peypoch, N, Robinot E, Solonandrasana B and Assaf G (2011) Performance of French destinations: Tourism attraction perspectives. *Tourism Management* 32(1): 141-146.

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

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

Barros CP and Mascarenhas MJ (2005) Technical and allocative efficiency in a chain of small hotels. *International Journal of Hospitality Management* 24: 415–436.

Barros C, Peypoch N and Solonandrasana B. (2009) Efficiency and productivity growth in hotel industry. *International Journal of Tourism Research* 11(4): 389-402.

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.

Brown JR, Ragsdale CT (2002) The competitive market efficiency of hotel brands: an application of data envelopment analysis. *Journal of Hospitality & Tourism Research* 26(4): 332–360.

Charnes A, Clark CT, Cooper WW and Golany B (1984) A developmental study of data envelopment analysis in measuring the efficiency of maintenance units in the US air forces. *Annual of Operational Research* 2(1): 95–112.

Charnes A, Cooper WW, Golany B, Seiford L and Stutz J (1985) Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions. *Journal of Econometrics* 30(1): 91–107.

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

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

Chen CM and Chang KL (2013) Cost Efficiency and the Choice of Operation Type: Evidence from Taiwan's International Tourist Hotels. *Asia Pacific Journal of Tourism Research* 18(8): 880-893.

Cheng H, Lu YC and Chung JT (2010) Improved slack-based context-dependent DEA: a study of international tourist hotels in Taiwan. *Expert Systems with Applications* 37(9): 6452–6458.

Chiang WE, Tsai MH and Wang LS (2004) A DEA evaluation of Taipei hotels. *Annals of Tourism Research* 31(3): 712–715.

Chiu YH and Huang CW (2011) Evaluating the optimal occupancy rate, operational efficiency, and profitability efficiency of Taiwan's international tourist hotels. *Service Industries Journal* 31: 2145–2162.

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

Coltman MM (1978) Hospitality management accounting. *CBI Publishing Co Inc, Boston*

Corne A (2015) Benchmarking and tourism efficiency in France. *Tourism Management* 51: 91–95.

Cruz MMP (2017) The Operational Efficiency and Sustainability of Selected De Luxe Class Hotels in Metro Manila. *European Journal of Business and Management* 27(9): 135-149.

Emrouznejad A (2005) Measurement efficiency and productivity in SAS/OR. *Computers and Operations Research* 32: 1665–1683.

Färe R and Grosskopf S (1996) Productivity and intermediate products: a frontier approach. *Economics Letters* 50(1): 65–70.

Färe R and Grosskopf S (2000) Network DEA. *Socio-Economic Planning Sciences* 34(1): 35–49.

Färe R and Lovell CAK (1978) Measuring the technical efficiency of production. *Journal of Economic Theory* 19: 150–162.

Fernández MA and Becerra R (2015) An Analysis of Spanish Hotel Efficiency. *Cornell Hospitality Quarterly* 56(3): 248–257.

Ferrera JMC and Tzeremes NG (2017) Evaluating hotel productivity growth in Balearic and Canary islands. *Tourism Economics* 23(1): 1146-1154.

Gross M and Huang S (2013) The domestic development experience of a hotel firm with Chinese characteristics: the case of Jin Jiang. *Cornell Hospitality Quarterly* 54(2): 211-224.

Gross M, Gao H and Huang S (2013) China hotel research: A systematic review of the

English language academic literature. *Tourism Management Perspectives 6*: 68-78.

Haugland SA, Myrtveit I and Nygaard A (2007) Market orientation and performance in the service industry: a data envelopment analysis. *Journal of Business Research* 60(11): 1191–1197.

Hou Q and Wang DM (2015) Technical efficiency evaluation of Retail Listed Companies Based on super efficiency SBM model. *Operation and Management* 5: 124–126.

Hsieh LF and Lin LH (2010) A performance evaluation model for international tourist hotels in Taiwan: an application of the relational network DEA. *International Journal of Hospitality Management* 29(1): 14–24.

Hu JL, Chiu CN, Shieh HS and Huang CH (2010) A stochastic cost efficiency analysis of international tourist hotel in Taiwan. *International Journal of Hospitality Management* 29(1): 99-107.

Hu YN, Mei L and Wei JG (2017) Industry efficiency of China's hotels: Time-space evolution and driving mechanism. *World Regional Studies* 26(3): 114–123.

Hu JL, Shieh HS, Huang CH and Chiu CN (2009) Cost efficiency of international tourist hotels in Taiwan: A data envelopment analysis application. *Asia Pacific Journal of Tourism Research* 14: 371-384.

Huang CW (2016) 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 CW, Chen HY and Ting CT (2017) Using a network data envelopment analysis model to assess the efficiency and effectiveness of cultural tourism promotion in Taiwan. *Journal* *of Travel & Tourism Marketing* 34(9): 1274–1284.

Huang CW, Chiu YH, Ting CT and Lin CH (2012) Applying a hybrid DEA model to evaluate the influence of marketing activities to operational efficiency on Taiwan's international tourist hotels. *Journal of the Operational Research Society* 63(4): 549–560.

Huang CW, Chiu YH, Tu CH, Luo ZY and Wang ZB (2016) Using the nonhomogeneous frontier two-stage DEA model to assess the efficiencies of expense utilization and operation of the Taiwanese hotel industry. *International Transactions in Operational Research* 23: 1067–1087.

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

Hung WT, Shang JK and Wang FC (2010) Pricing determinants in the hotel industry: Quantile regression analysis. *International Journal of Hospitality Management* 29(3): 378-384.

Hwang S and Chang T (2003) Using data envelopment analysis to measure hotel managerial efficiency change in Taiwan. *Tourism Management* 24(4): 357–369.

Johns N, Howcroft B and Drake L (1997) The use of data envelopment analysis to monitor hotel productivity. *Progress in Tourism & Hospitality Research* 3(2): 119–127.

Keh HT, Chu S and Xu J (2006) Efficiency, effectiveness and productivity of marketing in services. European Journal of *Operational Research* 170(1): 265–276.

Kohli U (1982) Relative price effects and the demand for imports. *The Canadian Journal of Economics* 15(2): 203–219.

Lee YH, Lu LT and Sung AD (2012) A measure to the operational performance of international hotels in Taiwan: DEA and Malmquist approach. *Review of Economics & Finance* 2: 73–83.

Li Y and Huang S (2017) Hospitality service climate, employee service orientation, career aspiration and performance: a moderated mediation model. *International Journal of Hospitality Management* 67:24-32.

Li JP, Li MR and Gao JY (2012) Report on overall competitiveness of China’s provincial economy during the eleventh five-year program. *Beijing: Social Science Document Press*.

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

Long ZK, Li XM, and Du QW (2016) Measure and Evaluation of the Development Efficiency of City Hotel Industry---- Case Study of Cities of Pearl River Delta. *Journal of Nanjing University Finance and Economics* (2): 78-85.

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.

Manasakis C, Apostolakis A and Datseris G (2013) Using data envelopment analysis to measure hotel efficiency in Crete. *International Journal of Contemporary Hospitality Management* 25(4): 510–535.

Martínez-Ross E and Orfila-Sintes F (2012) Training plans, manager's characteristics and innovation in the accommodation industry. *International Journal of Hospitality Management* 31(3): 686–694.

Pereira-Moliner J, Claver-Cortés E, and Molina-Azorín J (2011) Efectos empresa, grupo estratégicoy
localización en el sector hotelero español. *Cuadernos de Economía y Dirección de la Empresa* 14(2): 123-138.

Morey RC and Dittman DA (1995) Evaluating a hotel GM's performance: a case study in benchmarking. *Cornell Hotel Restaurant and Administration Quarterly* 36(5): 30–35.

National Bureau of Statistics China. (2007-2016). Yearbook of China Tourism Statistics. Beijing, China.

Oliveira R, Pedro MI and Marques RC (2013) Efficiency and its determinants in Portuguese hotels in the Algarve. *Tourism Management* 36(3): 641-649.

Parte-Esteban L and Alberca-Oliver P (2015) Determinants of technical efficiency in the Spanish hotel industry: regional and corporate performance factors. *Current Issues in Tourism* 18(4): 391-411.

Pastor JT, Ruiz JL and Sirvent I (1999) An enhanced DEA Russell-graph efficiency measure. *European Journal of Operational Research* 115(3): 596–607.

Poldrugovac K, Tekavcic M and Jankovic S (2016) Efficiency in the hotel industry: an empirical examination of the most influential factors. *Economic Research-Ekonomska Istraživanja* 29(1): 583-597.

Pulina M, Detotto C and Paba A (2010) An investigation into the relationship between size and efficiency of the Italian hospitality sector: a window DEA approach. *European Journal of Operational Research* 204(3): 613–620.

Sainaghi R (2011) Price determinants of individual hotels: evidence from Milan. *Tourism*

Review 66(4): 18-29.

Sanjeev GM (2007) Measuring efficiency of the hotel and restaurant sector: the case of India. International *Journal of Contemporary Hospitality Management* 19(5): 378–387.

Shang JK, Wang FC and Hung WT (2010) A stochastic DEA study of hotel efficiency. Applied Economics 42(19): 2505–2518.

Sun JR (2014) A study on the dynamic change of the efficiency of Chinese hotel industry and its influencing factors. *Journal of Nanjing xiaozhuang university* 11(6): 91-96.

Sun S and Lu WM (2005) Evaluating the performance of the Taiwanese hotel industry using a weight slacks-based measure. *Asia-Pacific Journal of Operational Research* 22(4): 487–512.

Sun JR, Zhang J, Zhang JH, Zhong SE, Ma JH and Zhang YL (2012) Spatial characteristics and optimization countermeasures of Chinese city hotel industry efficiency. *Economic Geography* 32(8): 155–159.

Tone K (1997) DEA with controllable category levels. In Proceedings of the spring national conference of the operation research society of Japan 126–127.

Tone K (2001) A slacks-based measure of efficiency in data envelopment analysis. European Journal of *Operational Research* 130: 498–509.

Tone T (2002) A slacks-based measure of super-efficiency in data envelopment analysis. *European Journal of Operational Research* 143: 32–41.

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.

Tsaur S (2000) The operating of international tourist hotels in Taiwan. *Asia-Pacific Journal* *of Tourism Research* 6(1): 29–37.

Untong A (2013) Operational Efficiency and Technology Gap Ratio of Hotels under Different Environments (in Thai). *Applied Economics Journal* 20(2): 37-54.

Van Doren CS and Gustke L (1982) Spatial analysis of the U.S. lodging industry. *Annals of Tourism Research* 9(4):543-563.

Wan XJ, Wu N and Wu T (2007) Hotel growth quality difference analysis and influencing factor in central China. *Economic Management* 19: 82–85.

Wang ZF and Fan JG (2013) A Study on Integration of Tourism Industry and Information Industry in Western Regions. *Journal of Minzu University of China (Philosophy and Social Sciences Edition)* 40(5): 78–85.

Wang F, Hung W and Shang J (2006) Measuring the cost efficiency of international tourist hotels in Taiwan. *Tourism Economics* 12: 65–85.

Wassenaar K and Stafford ER (1991) The lodging index: an economic indicator for the hotel/motel industry. *Journal Travel Research* 30(1):81-121

Wu YM (2014) Spatial panel econometric analysis of tourism economic growth and its spillover effects. *Tourism Tribune* 29(2): 16–24.

Wu J, Tsai H and Zhou Z (2011) Improving efficiency in international tourist hotels in Taipei using a non-radial DEA model. *International Journal of Contemporary Hospitality Management* 23(1): 66–83.

Xie CS, Wang EX and Zhu YL (2012) A study on efficiency evaluations of China's five-star hotels: based on super-efficiency DEA model. *Tourism Science* 26(1): 60–71.

Yang C and Lu WM (2006) Performance benchmarking for Taiwan's international tourist hotels. *Infor Information System & Operational Research* 44(3): 229–245.

Yang Y and Wong KKF (2012) A spatial econometric approach to model spillover effects in tourism flows. *Journal of Travel Research* 51(6): 768–778.

Yang ZS, Xia L and Cheng Z (2017) Performance of Chinese hotel segment markets: Efficiencies measure based on both endogenous and exogenous factors. *Journal of Hospitality and Tourism Management* 32: 12–23.

Yang ZS, Xia L, Zhong LS and Hu RS (2015) China's regional hotel industry: efficiencies and promotion. *Tourism Tribune* 30(5): 31–44.

Yi TT and Liang MZ (2015) Evolutional model of tourism efficiency based on the DEA method: A case study of cities in Guangdong Province, China. *Asia Pacific Journal of Tourism Research* 20(7): 789–806.

Yin PZ, 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 L and Gu H (2005) Hotel reform in China: a SWOT analysis. *Cornell Hotel and Restaurant Administration Quarterly* 46(2): 153–169.

Yu MM and Lee BCY (2009) Efficiency and effectiveness of service business: Evidence from international tourist hotels in Taiwan. *Tourism Management* 30(4): 571–580.

Zaman M, Botti L and Thanh TV (2016) Does managerial efficiency relate to customer satisfaction?: the case of Parisian boutique hotels. *International Journal of Culture Tourism & Hos* 10(4): 455-470.

Zhang YF (2017) Spatial and temporal evolution of star-rated hotels'efficiency in China based on DEA-Malmquist model. *Scientia Geographica Sinica* 37(3): 406-415.

Zhang H and Cheng ZD (2014) Evaluation and analysis of Chines star-rated hotels' efficiency in different regions based on method of DEA. *Resource Development & Market* 30(10): 1207–1212.

Zhang Q and Ma JH (2011) Research on business efficiency of hotel and tourism enterprises based on the influence of innovation factors. *Energy Procedia* 5: 742–746.

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.

Table 1. Descriptive statistics of variables from 2006-2016

Variables	**Units**	**Min**	**Max**	**Average**	**S.D.**
Inputs					
Number of hotels	Number	48	1169	396.5	239.2
Number of rooms	Number	5224	152891	49181.95	32999.7
Fixed capital stock	Thousand RMB	474229.3	77281503	13463380.8	14270297
Number of employees	People	3594	188642	50100.1	37865.3
Outputs					
Occupancy rates	%	18.23	77.68	56.91	7.28
Operating revenues	Thousand RMB	8775.3	1586880	303380.8	387401.9

Table 2. Operational efficiencies of hotels in 31 provinces and municipalities.

Unit	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Mean	Rank
Beijing	1.083	1.069	1.063	1.064	1.062	1.099	1.092	1.072	1.067	1.067	1.060	1.073	5
Tianjin	0.856	0.856	1.002	1.009	1.012	1.033	1.044	1.144	1.167	1.137	1.136	1.036	7
Hebei	0.519	0.518	0.507	0.499	0.817	0.519	0.504	0.479	0.460	0.406	0.409	0.512	26
Shanghai	1.318	1.361	1.399	1.384	1.453	1.297	1.306	1.388	1.462	1.458	1.394	1.384	2
Jiangsu	0.604	0.603	0.605	0.596	0.584	0.666	0.646	0.561	0.559	0.554	0.538	0.592	19
Zhejiang	1.256	1.250	1.244	1.250	1.243	1.241	1.217	1.186	1.160	1.132	1.109	1.208	3
Fujian	0.577	0.584	0.581	0.818	0.711	0.656	0.581	0.530	0.622	0.676	0.512	0.623	17
Shandong	0.807	1.004	0.757	0.611	0.653	0.677	0.641	0.548	0.505	0.495	0.475	0.652	15
Guangdong	0.580	0.624	0.776	0.757	0.559	0.635	0.640	0.572	0.549	0.529	0.534	0.614	18
Hainan	0.400	0.401	0.426	0.567	0.635	1.052	1.004	0.644	1.030	1.019	1.001	0.744	14
Shanxi	1.028	1.028	1.041	1.058	1.052	1.050	1.035	1.042	0.861	1.028	0.881	1.009	9
Anhui	1.067	1.052	1.023	1.002	0.665	0.664	0.651	0.633	0.628	0.496	0.475	0.759	13

Jiangxi	0.598	0.403	0.513	1.010	0.577	0.511	0.497	0.435	0.546	0.492	0.400	0.544	22
Henan	0.803	0.765	1.097	1.056	0.862	0.912	1.004	1.013	1.041	1.039	1.027	0.965	10
Hubei	0.441	0.438	0.467	0.500	0.688	0.640	0.616	0.576	0.663	0.574	0.486	0.553	21
Hunan	1.076	1.056	1.054	1.101	1.061	1.068	1.092	1.099	1.076	1.062	1.042	1.072	6
Inner Mongolia	0.784	0.690	0.691	0.695	0.605	0.659	0.632	0.574	0.582	0.478	0.536	0.630	16
Guangxi	0.413	0.388	0.433	0.487	0.621	0.723	0.576	0.486	0.512	0.451	0.379	0.497	29
Chongqing	0.771	0.745	0.715	0.729	0.733	0.827	0.849	0.808	0.947	1.003	0.643	0.797	12
Sichuan	0.371	0.374	0.398	0.496	0.623	0.685	0.706	0.411	0.502	0.464	0.489	0.502	27
Guizhou	1.000	0.644	0.660	0.636	1.029	1.057	1.052	1.044	1.085	1.075	1.023	0.937	11
Yunnan	0.385	0.412	0.506	0.586	0.573	0.656	0.636	0.638	0.529	0.475	0.475	0.534	23
Tibet	0.999	0.408	1.091	0.317	1.110	1.207	1.084	1.467	1.259	1.260	1.159	1.033	8
Shaanxi	0.354	0.381	0.399	0.783	0.611	0.643	0.526	0.423	0.458	0.537	0.369	0.499	28
Gansu	0.530	0.494	0.481	0.525	0.462	0.580	0.558	0.536	0.544	0.495	0.440	0.513	25
Qinghai	1.090	1.118	1.317	1.342	1.047	1.117	1.226	1.184	1.087	1.099	1.243	1.170	4

Ningxia	1.661	1.733	1.864	1.711	1.513	1.232	1.082	1.119	1.185	1.103	1.162	1.397	1
Xinjiang	0.542	0.530	0.475	0.619	0.634	0.663	0.596	0.555	0.541	0.508	0.462	0.557	20
Liaoning	0.428	0.408	0.450	0.559	0.468	0.523	0.473	0.455	0.464	0.452	0.471	0.468	30
Jilin	0.433	0.437	0.470	0.511	0.481	0.495	0.557	0.534	0.607	0.589	0.611	0.521	24
Heilongjiang	0.370	0.358	0.396	0.414	0.412	0.443	0.469	0.488	0.558	0.547	0.501	0.451	31
Average	0.747	0.714	0.771	0.797	0.792	0.814	0.793	0.763	0.782	0.764	0.724	0.769	

Table 3. Operational efficiencies of hotels in four areas.

Area	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Average**
Eastern	0.800	0.827	0.836	0.856	0.873	0.888	0.868	0.812	0.858	0.847	0.817	0.844
Central	0.835	0.791	0.866	0.954	0.817	0.808	0.816	0.800	0.802	0.782	0.718	0.817
Western	0.742	0.660	0.752	0.744	0.797	0.837	0.793	0.770	0.769	0.746	0.698	0.755
Northeastern	0.410	0.401	0.439	0.495	0.454	0.487	0.499	0.493	0.543	0.529	0.527	0.480

Table 4. Comparison of input and output inefficiency in provinces and four areas with inefficient hotels in 2011.

	$Iineff_1$	$Iineff_2$	$Iineff_3$	$Iineff_4$	Iineff	$Oineff_1$	$Oineff_2$	Oineff
Hebei	0.647	0.588	0	0.669	0.476	0.019	0	0.009
Jiangsu	0.541	0.358	0.026	0.411	0.334	0	0	0
Fujian	0.132	0.354	0.358	0.532	0.344	0	0	0
Shandong	0.422	0.311	0.136	0.421	0.323	0	0	0
Guangdong	0.416	0.358	0.194	0.492	0.365	0	0	0
Eastern	0.432	0.394	0.143	0.505	0.368	0.004	0	0.002
Anhui	0.459	0.444	0	0.440	0.336	0	0	0
Jiangxi	0.432	0.496	0.583	0.447	0.489	0	0	0
Henan	0.123	0.177	0	0.040	0.085	0.005	0	0.003
Hubei	0.515	0.420	0.105	0.401	0.360	0	0	0
Central	0.382	0.384	0.172	0.332	0.318	0.001	0	0.001
Inner Mongolia	0.453	0.374	0.109	0.426	0.341	0	0	0

Guangxi	0.182	0.345	0.289	0.294	0.277	0	0	0
Chongqing	0	0.157	0.168	0.366	0.173	0	0	0
Sichuan	0.408	0.223	0.346	0.285	0.315	0	0	0
Yunnan	0.605	0.455	0	0.314	0.344	0	0	0
Shaanxi	0	0.241	0	0.370	0.153	0	0.635	0.317
Gansu	0.520	0.441	0.299	0.419	0.420	0	0	0
Xinjiang	0.295	0.361	0.433	0.259	0.337	0	0	0
Western	0.308	0.325	0.206	0.342	0.295	0	0.079	0.040
Liaoning	0.596	0.405	0.462	0.447	0.477	0	0	0
Jilin	0.568	0.363	0.601	0.433	0.491	0.055	0	0.028
Heilongjiang	0.654	0.487	0.624	0.398	0.541	0.073	0	0.036
Northeastern	0.606	0.419	0.562	0.426	0.503	0.043	0	0.021
Average	0.398	0.368	0.237	0.393	0.349	0.008	0.032	0.02

Table 5. Comparison of input and output inefficiency in provinces and four areas with inefficient hotels in 2016.

	$Iineff_1$	$Iineff_2$	$Iineff_3$	$Iineff_4$	**Iineff**	$Oineff_1$	$Oineff_2$	**Oineff**
Hebei	0.718	0.588	0.249	0.583	0.534	0.276	0	0.138
Jiangsu	0.672	0.450	0.07	0.545	0.434	0.102	0	0.051
Fujian	0.600	0.525	0	0.613	0.434	0	0.209	0.105
Shandong	0.747	0.564	0.057	0.606	0.494	0.132	0	0.066
Guangdong	0.651	0.478	0.093	0.422	0.411	0.205	0	0.102
Eastern	0.677	0.521	0.094	0.554	0.461	0.143	0.042	0.092
Shanxi	0.177	0.012	0	0.088	0.063	0.113	0	0.057
Anhui	0.708	0.578	0.069	0.648	0.501	0.103	0	0.051
Jiangxi	0.714	0.611	0.466	0.570	0.590	0.046	0	0.023
Hubei	0.715	0.529	0.185	0.606	0.509	0.021	0	0.011
Central	0.579	0.433	0.180	0.478	0.416	0.071	0	0.035
Inner Mongolia	0.535	0.379	0.299	0.547	0.440	0.092	0	0.046

Guangxi	0.765	0.616	0.300	0.772	0.613	0.043	0	0.021
Chongqing	0.534	0.344	0.066	0.467	0.353	0.014	0	0.007
Sichuan	0.623	0.435	0.482	0.478	0.505	0.026	0	0.013
Yunnan	0.802	0.572	0.117	0.560	0.513	0.052	0	0.026
Shaanxi	0.691	0.561	0.510	0.731	0.623	0.041	0	0.020
Gansu	0.729	0.590	0.289	0.562	0.542	0.082	0	0.041
Xinjiang	0.729	0.550	0.211	0.506	0.499	0.168	0	0.084
Western	0.676	0.506	0.284	0.578	0.511	0.065	0	0.032
Liaoning	0.643	0.437	0.515	0.305	0.475	0.232	0	0.116
Jilin	0.408	0	0.270	0.097	0.194	0	0.641	0.321
Heilongjiang	0.557	0.462	0.594	0.335	0.487	0.048	0	0.024
Northeastern	0.536	0.300	0.460	0.245	0.385	0.093	0.214	0.153
Average	0.636	0.464	0.242	0.502	0.461	0.090	0.043	0.066

* The meaning of $Iineff_1$, $Iineff_2$, $Iineff_3$, $Iineff_4$, Iineff, $Oineff_1$, $Oineff_2$, and Oineff was the same with that in Table 4.

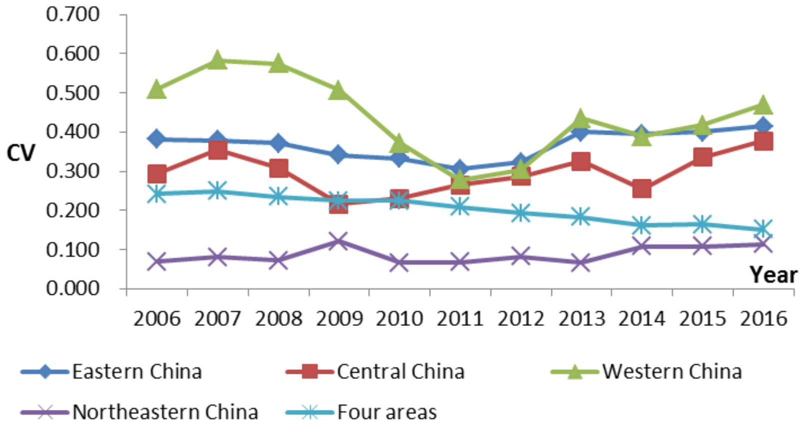

Figure 1. Coefficients of variation of four areas.