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The influence of the internet on catering and accommodation industry efficiency

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ABSTRACT

Accommodation and catering industry efficiencies have been widely evaluated from destination, market concentration, and catering supply chain management perspectives; however, few studies have dynamically evaluated the overall accommodation and catering industry efficiencies under the influence of the internet. Therefore, to go some way to filling this research gap, this study used catering and accommodation industry data and related internet data from 31 Chinese provinces from 2012 to 2016 and employed a Dynamic DDF DEA model to evaluate the catering and accommodation industry efficiencies and the influence of the rising internet connections. It found that: 1. the overall catering and accommodation revenue efficiencies were higher when the internet connection inputs were considered; and 2. there were significant catering and accommodation income distribution differences between the eastern, central and western regions, with higher efficiencies being found in the more developed east.

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1. Introduction

Internet access has provided new opportunities for the tourism industry, with data access now considered as important as labour, capital, and technology. However, few previous studies have examined the data and internet influences on the catering and accommodation industry. The Covid-19 pandemic has further highlighted the importance of internet connections to local catering and accommodation industries, and it is expected that internet connections and data could result in structural supply-side tourism industry reforms in the near future. The Ministry of Culture and Tourism recently reported that the coronavirus outbreak in January 2020 and the consequent pandemic severely impacted China's tourism and hotel industry. On January 14, 2020, the Chinese mainland hotel occupancy rate was 70%; however, after two weeks

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it had fallen to only 8%. In the following 22 days, the market occupancy rate was less than 10%, but as the pandemic was slowly brought under control, it recovered slightly in early March to 14%. During the most severe period of the pandemic, some hotels closed and 80% closed their online booking channels (The Ministry of Culture & Tourism, 2021). As the number of new cases fell to zero, many hotels began resuming operations. However, because of the lack of international tourists and restrictions on domestic travel, the impact of the pandemic is still being felt by many hotel operators; therefore, a recovery strategy for the catering and accommodation industry that includes reforms and innovations is needed as soon as possible.

The Chinese National Bureau of Statistics reported that there was an annual growth of 15.23% in mainland internet users from 2013 to 2018, with around 800 million people regularly using the internet in 2018. The rapid rise in internet use has benefitted information reliant industries such as tourism, with online ticket sales of 480.90 billion CNY in 2017, a 27.1% increase on 2016, online train ticket sales of 329.94 billion CNY, an increase of 30.0% over 2016, and online accommodation market transactions of 181.94 billion CNY, an increase of 27.3% over 2016.

The ease of accessing information using the internet has resulted in a move away from traditional tourism industry modes such as travel agencies as potential consumers can easily find travel destination information on the internet. This had also significantly reduced the capital investment in businesses and customers, significantly improving transaction efficiency, user experiences, and customer satisfaction.

These changes have prompted increased research interest in accommodation and catering industry efficiency evaluations focussed on hotel destinations, length of stay, destination quality, market concentration, and catering supply chain management methods; however, these evaluations have tended to examine catering supply chain management efficiencies rather than overall accommodation and catering industry efficiencies, and even though data has been recognised as being as important as labour, capital, and technology, there have been few tourism industry efficiency studies that have included the use of data as a production factor.

Therefore, this paper has four main contributions. First, past literature shows that electronic technology can affect the operating efficiency of the catering and accommodation industry (Matias et al., 2013; Mudie & Vadhati, 2017; Wang et al., 2019; Yang et al., 2018; Zhao, 2011). Some literatures (Ang et al., 2018; Ashrafi et al., 2013; Huang et al., 2012; 2014) did not consider the Internet as an input to analyze operating efficiency when researched on the catering and accommodation industry. This study regards the Internet as an input item to analyze operating efficiency to make up for the deficiencies in the literature of the catering and accommodation industry. Second, this study takes labour and Internet technology as important indicators, and analyzing the impact of these indicators on the efficiency of the catering and accommodation industry is an important new contribution. Therefore, this research can provide new perspectives for enhancing the quality and management level of labour input in China's catering and accommodation industry. Third, there is no research on the differences between the eastern and western regions affected by Internet technology in the relevant literature of the catering and accommodation industry. China has a vast territory, and economic development in the east and west is subject to geographical restrictions. The eastern region has a more superior development basis, including flat terrain and more convenient transportation. The western region has complex geomorphology and inconvenient transportation, but it has richer tourism natural resources and can attract more tourists. Compared with other technologies, Internet technology has a certain value and significance for the development of regional catering and accommodation industry. Finally, in terms of methods, the past literature focussed on static analysis when discussing the operating efficiency of the catering and accommodation industry, but lacked dynamic analysis. In order to examine dynamic catering and accommodation industry efficiency changes, a Dynamic DDF DEA model is employed in this research to evaluate China's catering and accommodation industry efficiencies and the influence of the internet connections from 2012 to 2016 in 31 Chinese provinces/municipalities/autonomous regions.

2. Literature review

This section reviews previous tourism studies based on: tourism industry, catering industry and economic development; hotel operational efficiencies; and e-technology applications and hotel operations.

2.1. Tourism industry, catering industry and economic development

Tourism industry associated activities such as accommodation and catering contribute to social and economic development (Onețiu & Predonu, 2013), alleviate local poverty, and promote productivity (Huang, 2018; Li et al., 2018) and economic development (Zhang & Lin, 2018). In China; however, domestic tourism industry efficiency has been relatively low, with the eastern region efficiencies being generally higher than those in the central and western regions (Chaabouni, 2019; Song & Li, 2019; Sun, 2016). The hotel industry in particular has been found to be closely linked to regional economic development. For example, Yang et al. (2017) examined regional operational efficiencies in the mainland China hotel industry finding that there were versatile efficiencies, and Ferrari et al. used a multiplier model to analyse the tourist consumption impact on the local economy, finding that tourist consumption increased the demand for regional agricultural and industrial products.

However, the tourism sector is extremely sensitive to external factors. For example, Huang et al. (2012) found that the 2003 SARS outbreak significantly reduced hotel efficiency, and Ashrafi et al. (2013) found that as not all major events reduced Singapore's hotel industry efficiency, policy makers needed to pay attention to events such as terrorist attacks and infectious disease outbreaks that could lead to cancellations.

The catering industry, which is vital to service industry employment and economic growth, has also attracted significant management research (Bánáti & Lakner, 2012; Fusi et al., 2016; Matias et al., 2013; Mudie & Vadhati, 2017; Zhao, 2011). However, most studies have examined catering industry supply chain management methods rather than overall catering industry efficiencies.

2.2. Hotel operational efficiency

Hotel industry efficiencies have been widely examined over time and in different regions (Ang et al., 2018; Ashrafi et al., 2013; Huang et al., 2012; Huang et al., 2014;). For example, Ang et al. (2018) established a self-evaluation model to examine the group and group cross efficiencies in the Taiwanese hotel industry from 2011 to 2015, and applied a barrel theorem to define the average and worst efficiencies in the member groups, Huang et al. (2014) studied the catering service efficiencies in 58 Taiwanese international tourism hotels using a modified two-stage model, finding that the hotel chains, resorts, and hotel catering industries were more efficient, and Butnaru et al. designed a quality evaluation tourist service indicator and proposed a global quality tourism service evaluation index based on tourism service providers and consumers to assess tourism service quality. In a more recent study, Ribaudo et al. used a Foreign market Per Available Room (FmPAR) index to compare the sales capabilities in 148 brand hotels in 21 destinations in Italy, and found that the chain hotel sales capacities were better than the independent hotels, Sainaghi et al. proposed three tourism and hotel industry performance evaluation categories; efficiency, competitiveness, and productivity, and Zolfani et al.'a (2015) proposed that tourism research could classified based on (1) year of publication, (2) publication journal, and (3) subject area citations.

The hotel industry efficiency influencing factors in different regions have been widely examined to determine the impact of environmental factors such as location, occupancy rate, seasonality, market concentration, length of stay, international tourist numbers, and tourism resource quality (Lado-Sestayo & Fernández-Castro, Lado-Sestayo & Fernández-Castro, 2019; Sellers-Rubio and Casado-Díaz, Sellers-Rubio & Casado-Díaz, 2018). For example, Lado-Sestayo and Fernández-Castro (2019) studied 400 Spanish hotel locations using geolocation, agglomeration, urbanization, economic, and environmental competition models, and found that while the tourist destination was the main hotel efficiency determinant, occupancy, seasonality, and market concentration also played important roles. With a focus on length of stay, international tourist numbers, destination quality, and an environmental variable associated with sunshine and beach tourism characteristics, Sellers-Rubio and Casado-Díaz Sellers-Rubio and Casado-Díaz (2018) used a two-stage data envelopment analysis(DEA) method to study Spanish regional hotel efficiencies, finding that the efficiencies were low, and the environmental variable contributions were significant.

2.3 E-Technology applications and hotel operations

Internet developments have led to major changes in the hotel industry, with online evaluations in particular being found to significantly impact hotel efficiency, and with eWOM (electronic word of mouth) becoming an important form of customer expression. Mariani and Visani (2019) used an eWOW-informed DEA model to test 268 independent hotels in Rome, and found that the introduction of online scoring had had a significant effect on hotel efficiency, that the number of hotels with increased efficiencies were lower than the number of hotels with decreased efficiencies. Yang et al. (2018) concluded that large and medium-sized hotels needed to pay greater attention to online ratings, and in a study on the relationships between research model quality, information quality, service quality, product quality, perceived price, perceived promotion, perceived value, user satisfaction, reuse intention and eWOM, Wang et al. (2019) found that perceived value had a greater impact on eWOM. Research has also evaluated hotel industry efficiency based on online hotel service factors (Yang et al., 2018). For example, Labanauskaitė et al. (2020) surveyed 384 tourists and found that electronic marketing tools were helpful to Lithuania's tourism industry, and Secondi et al. used questionnaires and a structural equation model to analyse the impact of corporate infrastructure, urban infrastructure, tourist mobility and tourism resources on cultural tourism, find that increasingly more tourists were using the internet to plan their holidays.

While previous studies have recognised the impacts that electronic technology has had on the tourism industry, no studies have used DEA methods to examine catering and accommodation industry efficiency changes when the internet influence was included, with most previous studies having only examined the effects on catering industry supply chain management (Bánáti & Lakner, 2012; Fusi et al., 2016; Matias et al., 2013; Mudie & Vadhati, 2017; Zhao, 2011). Therefore, to explore the impact of the internet on catering and accommodation industry efficiencies and illustrate the important role the internet plays in the modern service industry, this study uniquely included internet connections as an input item, and compared the efficiency differences before and after adding the internet connections input item.

3. Research model and method

Data Envelopment Analysis (DEA) has been found to be an effective way to evaluate priorities in multiple decision-making scenarios. Originally proposed by Farrell (1957), over time, DEA has been significantly improved. Charnes et al. (1978) extended Farrell's theory to include multiple inputs and multiple outputs to develop the CCR model, after which Banker et al. (1984) incorporated convexity constraints and adjusted the constant-returns-to-scale to a variable-returns-to-scale to develop the BCC model. However, as both these models only measured radial efficiency and assumed that the inputs and outputs proportionally increased or decreased, Tone (2001) then developed a non-radial slacks-based measure (SBM) to determine optimal efficiency.

As these conventional DEA methods failed to include undesirable outputs, based on an extension of the output distance function concept in Shephard (1970), Luenberger (1992) and Chung et al. (1997) proposed a radial directional output distance function to include both desirable and undesirable outputs under the same production basis, thereby allowing for an analysis of the increase or decrease in bad output. However, because these radial efficiency models ignored the variances in the variables that could lead to estimation errors, Zhou et al. (2012), Chiu et al. (2012), Barros et al. (2012), and Zhang and Choi (2013) included non-radial directional distance functions in their energy and environmental efficiency analyses.

Dynamic analysis was first proposed by Kloop in 1985 and was further developed by Färe et al. (1994) to measure intertemporal efficiency changes. However, as these models did not consider the effects of the intertemporal continuation activities, they were less suitable for long-term efficiency measurements; therefore, Färe and Grosskopf (1996) proposed a carry-over with cross-linking variables, which was then used and further evolved by Bogetoft et al. (2008), Chen (2009), Kao (2008), Nemoto and Goto Nemoto and Goto (1999, Nemoto & Goto, 2003), and Chang et al. (2009), and in 2010, Tone and Tsutsui (2010) extended the model to dynamic SBM analysis.

3.1. Research model: dynamic DDF DEA

This study used panel data from 31 eastern and western Chinese provinces/municipalities/autonomous regions, each of which had economic aggregate, industrial planning, and energy consumption commonalities. Six variables were then chosen: two input variables; catering and accommodation industry employees, and internet connections; three output variables; accommodation revenue, food service revenue, and catering revenue; and one carry-over variable; fixed assets.

Assume that N provinces have two inputs; catering and accommodation industry employees (L) and internet connections (IC); three outputs; accommodation revenue (Y), food service revenue (FY), and catering revenue(C); and a fixed assets carry over. The contemporaneous production technology for group R_h at time t, therefore, is defined as $T^C = \{(L^t, IC^t, Y^t, FY^t, C^t) : (L^t, Z^t, IC^t) \text{ to produce } (Y^t, FY^t, C^t)\}$, with Z^t being the carry over and where $t = 1, \ldots, T$. Following Färe and Grosskopf (2010), Tone and Tsutsui (2010), Zhou et al. (2012), and Zhang and Choi (2013), the Dynamic DDF non-radial directional distance function is expressed as;

$$\max \sum_{t=1}^{T} \beta_{tL} + \beta_{tIC} + \beta_{tY+}\beta_{tFY+}\beta_{tC} \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\text{s.t.} \quad \sum_{t=1}^{T}\sum_{n=1}^{N} \lambda_{nt} L_{nt} \leq (1 - \beta_L) L_{0t}, \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\sum_{t=1}^{T}\sum_{n=1}^{N} \lambda_{nt} IC_{nt} \leq (1 - \beta_{IC}) IC_{0t}, \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\sum_{t=1}^{T}\sum_{n=1}^{N} \lambda_{nt} Y_{nt} \leq (1 + \beta_Y) Y_{0t}, \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\sum_{t=1}^{T}\sum_{n=1}^{N} \lambda_{nt} FY_{nt} \leq (1 + \beta_{FY}) FY_{0t}, \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\sum_{t=1}^{T}\sum_{n=1}^{N} \lambda_{nt} C_{nt} \leq (1 + \beta_C) C_{0t}, \quad n = 1 \cdots N \;\; t = 1, 2, \ldots, T$$

$$\sum_{t=1}^{T}\sum_{n=1}^{N}\lambda_{nt-1}Z_{nt} = \sum_{t=1}^{T}\sum_{j=1}^{N}\lambda_{nt}Z_{nt},\ \ n = 1\cdots N\ \ t = 1,2,\ldots,T$$

$$\sum_{n=1}^{N}\lambda_{nt} = 1\ \ n = 1\cdots N\ \ t = 1,2,\ldots,T \tag{1}$$

$$1 > \beta_L \geq 0;\ \ 1 > \beta_{IC} \geq 0;\ \ 1 > \beta_Y \geq 0;\ \ 1 \geq \beta_{FY} \geq 0;\ \ 1 \geq \beta_C \geq 0$$

$$\lambda_n \geq 0;\ \ n = 1, 2, \ldots N,\ \ t = 1, 2, \ldots, T$$

where n represents the provinces/municipalities, t represents time, and β represents the direction distance. For efficiency improvements, the input would need to be reduced and the output increased.

3.2. Efficiency index models

Hu and Wang (2006) total-factor energy efficiency index was used to overcome any possible biases in the traditional energy efficiency indicators. For each specific evaluated province/municipality, the efficiencies for the accommodation and catering industry employees, internet connections, and accommodation, food service, and catering revenues were calculated using Equations (2) - (6).

$$\text{Accommodation/catering employees} = \frac{\text{Target accommodation and catering employee input (i, t)}}{\text{Actual accommodation and catering employee input (i, t)}} \tag{2}$$

$$\text{Internet connections} = \frac{\text{Actual internet connections input (i, t)}}{\text{Target internet connections input (i, t)}} \tag{3}$$

$$\text{Accommodation revenue} = \frac{\text{Actual accommodation revenue output (i, t)}}{\text{Target accommodation revenue output (i, t)}} \tag{4}$$

$$\text{Food service revenue} = \frac{\text{Actual food service revenue output (i, t)}}{\text{Target food service revenue output (i, t)}} \tag{5}$$

$$\text{Catering revenue} = \frac{\text{Actual catering revenue output (i, t)}}{\text{Target catering revenue output (i, t)}} \tag{6}$$

If the target accommodation/catering employee and internet connection inputs were equal to the actual inputs, then the efficiencies equalled 1, indicating overall efficiency; however, if the target accommodation/catering employee and internet connection inputs were less than the actual inputs, then the inputs were less than 1, indicating overall inefficiency. If the target accommodation revenue, food service revenue, and catering revenue outputs were equal to the actual accommodation revenue, food service revenue, and catering revenue outputs, then the efficiency outputs equalled 1, indicating overall efficiency; however, if the actual accommodation revenue, food service revenue, and catering revenue outputs were less than the target outputs, then the efficiency was less than 1, indicating overall inefficiency.

4. Data, index definition and statistical analysis

4.1. Input output indicators

The research model indicators were divided into input indicators and output indicators to study the impact on the catering and accommodation industry efficiencies in the 31 Chinese provinces, the descriptions for which are given in the following.

Inputs:

Accommodation/catering employees: Total number of employees working in the accommodation and catering industries in each province/municipality/autonomous region: unit: person

Internet connections: The total internet broadband users in each province/municipality/autonomous region: unit: person

Outputs:

Accommodation revenue: hotel and tourist resort accommodation revenue: unit: CNY

Food service revenue: revenue from the accommodation industry catering businesses: unit: CNY

Catering revenue: Total catering industry revenue: unit: CNY

The data for this study were extracted from the China National Economic Statistics Yearbooks and the provincial/municipality/autonomous region Economic Statistics yearbooks.

4.2. Statistical index analyses

The basic overall statistical analyses of the input and output indicators from 2012 to 2016 indicated that the maximum, minimum, and average accommodation and catering industry labour inputs were constant from 2012 to 2014, then declined, and the maximum, minimum, and average internet connections in mainland China continued to rise, with significant increases after 2014. The accommodation industry and the catering industry maximum, minimum, and average income indicators decreased significantly from 2012 to 2014, slowly recovered after 2015 and increased significantly in 2016.

5. Results and analysis

5.1. Total efficiency analyses

The total efficiencies in the 31 Chinese provinces/municipalities/autonomous regions were calculated with and without the internet connection input variable (Table A1 see Appendix). When the internet connection input was not included, only Shanghai had a total efficiency of 1 in each year, with Beijing, Fujian, Hainan, Shandong and Zhejiang having total efficiencies over 0.6, and Beijing's reaching 1 in several years. In 2013 and 2014, Guangdong, Hunan, Jiangsu, Liaoning and Sichuan achieved overall efficiencies between 0.4 and 0.6, but only Hunan and Liaoning had efficiencies above 0.5. The overall efficiencies in the remaining provinces were low in all five years, especially in Heilongjiang, Qinghai and Tibet. The overall efficiencies in most provinces showed small upward trends, with the largest being in Shandong from 0.7 in 2012 to 0.8 in 2016. Beijing, Fujian, Hainan, Jilin, and Sichuan had fluctuating small downward total efficiency trends, with Beijing experiencing the largest fall from 0.98 in 2012 to 0.94 in 2016.

When the internet connection input was included, the overall catering and accommodation industry revenue efficiencies were higher, with Shanghai, Beijing and Hainan all having total efficiencies of 1 in all years, most other provinces having higher efficiencies, and Tibet's improving significantly. However, when the internet connection input was not included, Chongqing, Gansu, Ningxia, Qinghai, and Tianjin had upward trending overall catering and accommodation industry efficiencies, but when the internet connection input was included, these five provinces and municipalities had downward trends, indicating that the catering and accommodation industry management had been unable to fully harness the benefits of the increased internet connections in these provinces.

The catering and accommodation industry income distribution had a clear east to west distribution, with the more developed coastal regions in the east tending to have higher efficiencies with and without the internet connection input. The catering and accommodation industry income efficiencies in Beijing and Hainan appeared to have benefitted most from the internet, possibly because both have rich tourism resources and large tourist inflows. However, while the internet connection growth resulted in downward overall catering and accommodation industry efficiency trends in some regions, the absolute overall efficiencies were still higher when the internet connection input was included.

5.2. Input-output index efficiency analysis

A comparison efficiency analysis was conducted for each input-output indicator with and without the inclusion of the internet connection input.

5.2.1. Employee efficiency

Table A2 (see Appendix) compares the accommodation and catering employee efficiencies with and without the internet connection input. When the internet connection input was not included, the accommodation and catering employee efficiencies varied greatly, with only Shanghai's efficiency being 1 in all years. Beijing's employee efficiency was 1 in 2013 and 2014 and high at 0.99 and 0.97 in the other years, and Fujian, Hainan, Shandong and Zhejiang had employee efficiencies mostly above 0.8. Guangdong, Hunan, Jiangsu, Liaoning, Shaanxi and Sichuan had catering employee efficiencies higher than 0.5 in most years, but Sichuan's efficiency was only 0.51 in

2015, Liaoning's was less than 0.50 from 2012 to 2013, and Shaanxi's was lower than 0.5 in 2014 and 2015. The employee efficiencies in the remaining provinces/municipalities/autonomous regions were all below 0.5, with most being between 0.3-0.5, except for Heilongjiang, Inner Mongolia, Jilin, Ningxia, Qinghai, Shanxi, Tianjin, Tibet and Yunnan, which were all below 0.3 in most years. Overall, however, the employee input efficiencies in most provinces/municipalities/autonomous regions had upward trends.

When the internet connection input was included, the employee input efficiencies increased in most years in most provinces/municipalities/autonomous regions, with the efficiencies in Beijing and Haikou being 1 in all years, improving in the three years from 2014 in Hubei, and increasing significantly from 2013 to 2016 in Tianjin, indicating that the internet connections were having positive effects. However, while the inclusion of the internet connection input led to employee efficiency falls in Chongqing, Qinghai, and Shaanxi in 2012 and 2013, the efficiencies were higher in the other years.

Table A3 (see Appendix) show that the internet connection input efficiencies varied significantly. Only Beijing, Hainan, and Shanghai had internet connection input efficiencies of 1 in all years, with Fujian, Guangdong, Hunan, and Zhejiang having internet connection input efficiencies above 0.6; however, the internet connection input efficiencies in the remaining provinces fell below 0.6 over the years, with the efficiencies in Anhui, Hebei, Heilongjiang, Inner Mongolia, Jilin, Ningxia, Qinghai, Shanxi and Xinjiang all being below 0.4.

The internet connection input efficiencies appeared to be related to the provincial economic development situations, with the lower-ranked, less developed central and western provinces and autonomous regions tending to have lower internet connection input efficiencies (see Table A3 in Appendix). Only Beijing, Hainan and Shanghai had maximum internet connection input efficiencies, indicating that the inclusion of this input could boost efficiency. However, as this was only obvious in the more developed regions, in the more economically backward regions, other relevant infrastructure development should be considered first.

5.2.2. Accommodation, food service, and catering revenue efficiencies

Table A4 (see Appendix) shows that when the internet connection input was not included, the accommodation revenue efficiency was 1 only in Shanghai; however, Beijing and Hainan's efficiencies were higher than 0.8. In most other provinces, the accommodation revenue efficiencies were between 0.6 and 0.8, but were below 0.6. in Anhui, Hebei, Inner Mongolia, Ningxia and Shanxi.

When the internet connection input was included, Shanghai, Beijing and Hainan all had accommodation revenue efficiencies of 1, indicating that the internet input had had a significant effect. However, the accommodation revenue efficiencies in most other provinces/municipalities/autonomous regions only marginally increased when the internet connections input was considered.

Table A5 (see Appendix) shows the food revenue efficiencies when the internet connection input was and was not included. When it was not included, Shanghai had a food revenue efficiency of 1 in all years, Beijing's was 1 in 2013 and 2014 and above 0.9 in the other years, Fujian, Hainan, Shandong, and Zhejiang's were higher than 0.8, and in all other provinces, was above 0.6, with Tibet's being the lowest at 0.62-0.65. When the internet connection input was included, the food service revenue efficiencies in Shanghai, Beijing and Hainan were 1, with the rankings in the other provinces changing significantly; in particular, Chongqing's food service revenue efficiency ranking rose from 19 to 12, Inner Mongolia's rose from 25 to 20, and Guizhou's rose from 16 to 13.

Table A6 (see appendix) shows the catering revenue efficiencies and rankings with and without the internet connection input. When the internet connection input was not considered, only Shanghai had a five-year catering revenue efficiency of 1, with Beijing's rising sharply in 2013 from 0.76 to 1 in 2013 and 2014, and then quickly falling back to 0.76 in 2015; however, the catering revenue efficiencies in the other 29 provinces/municipalities/autonomous regions were relatively low and stable, with only Chongqing and Tianjin having efficiencies above 0.6. When the internet connection input was considered, the catering revenue efficiencies in Shanghai, Beijing and Hainan were 1 in all years and there were some significant ranking changes. For example, Shandong's ranking dropped from 7 to 15 and Zhejiang, Shanxi, Liaoning and Anhui all dropped seven places. Nine provinces/municipalities/autonomous regions experienced significant ranking rises, with Tibet in particular rising from 31st to 10th, which indicated that internet developments had had a significant impact on catering revenue efficiency developments in Tibet.

Overall, the influence of the internet appeared to have positive but variable effects on the accommodation, food service, and catering revenue efficiencies. For example, in Tianjin, Qinghai and Tibet, the inclusion of the internet connection input resulted in a decrease in accommodation revenue efficiencies, but an increase in Tianjin's catering revenue efficiency from 0.70 to 0.76. The internet impact appeared to be greater in provinces/municipalities/autonomous regions that had more significant tourism resources, such as Beijing and Hainan, and smaller in provinces such as Qinghai and Tibet, which have significant folk tourism resources but very poor resource development and infrastructure. Therefore, the increasing internet connections were not found to result in significant improvements in local efficiencies as it is necessary to consider other support measures. Nonetheless, it could be surmised that over time, increasing internet connections could have a significant positive impact on tourism input and output efficiencies.

5.3. Limitations

Unfortunately, due to delays in accessibility to official data in China, complete matching data was only available from 2012 to 2016, which limited the timeliness of our research. Future research plans to expand the data and conduct more in-depth real-time data analysis.

6. Conclusions and policy recommendations

This paper used a Dynamic DDF DEA model to analyse the internet connection input effects on the catering and accommodation industry efficiencies in 31 provinces/municipalities/autonomous regions in China from 2012 to 2016. When the internet connection input was considered, the overall efficiencies in all provinces/municipalities/autonomous regions were found to be higher and the need for changes in some provinces and regions highlighted. For example, the catering and accommodation efficiencies in Chongqing, Gansu, Ningxia, Qinghai, and Tianjin were trending downward when the internet connection input was considered, which indicated that catering and accommodation development changes were needed to ensure that the local industry was harnessing the full power of the internet.

The catering and accommodation industry revenue distribution had high east and low west characteristics, with the eastern, more developed, coastal area provinces being more positively affected by the internet connection input. Except for Tibet, Chongqing, Qinghai, and Shaanxi, while the accommodation and catering employment efficiencies increased in most years in most regions when the internet connection input was included, the internet connection efficiencies varied greatly, with only Beijing, Hainan and Shanghai having efficiencies of 1 and Fujian, Guangdong, Hunan, and Zhejiang having efficiencies above 0.6.

The accommodation, food service and catering revenue efficiencies varied when the internet connection input was considered. The accommodation revenue efficiencies in Shanghai, Beijing and Hainan were 1, but in most other provinces/municipalities/autonomous regions, were between 0.6 and 0.8, with Anhui, Hebei, Inner Mongolia, Ningxia, and Shanxi's being below 0.6. The food service revenue efficiencies in Shanghai, Beijing, and Hainan were 1 in all years and generally increased in all other provinces and regions, and the catering revenue efficiencies were relatively stable with no obvious change trends regardless of whether the internet connection input was considered.

Overall, therefore, the accommodation industry and the catering industry efficiencies tended to reflect the economic development levels in each region, with the lower ranked provinces being in the less developed mid to western provinces. Only Shanghai achieved optimal efficiency, and when the internet connection input was considered, only Beijing, Hainan and Shanghai achieved perfect overall efficiency.

6.1. Policy recommendations

The inclusion of the internet connection input in the analysis resulted in increased efficiencies in most provinces/municipalities/autonomous regions, most noticeably in Tibet and Hainan, which indicated that the increase in internet connections had had a significant impact on the economic development in these less developed areas. However, as the overall and individual index efficiencies in the western region did not increase significantly, this implied that accommodation and catering industry designs based on local resource advantages and centred on service and quality were needed, which prompted the following policy recommendations.

First, in parallel with labour, capital, and technological improvements, all regions need to adjust their industrial economic structures to take advantage of internet technology, improve resource efficiency, and promote continued tourism industry development. To ensure increased tourism governance efficiency, information transparency, and customer service, internet technologies need to be strengthened, which in turn will strengthen enterprise competition and encourage better service, dining, and accommodation quality.

Second, to enhance service offerings and increase information acquisition, business transactions, and communication to better meet client needs, accommodation and catering industries need to fully harness the power of the internet to improve local industries. As large regional accommodation and catering industry efficiency differences were observed between the more developed eastern regions and the western regions, the less developed western regions need to improve their internet technologies and tourist resources to motivate local accommodation and catering industry development.

Third, to strategically transform the tourism sector, national, regional, and local efforts are needed to build a comprehensive integrated Chinese tourism internet facility and ensure the integration of the internet and associated communication technologies into traditional tourism industry functions.

Finally, to increase tourism information, protect consumers, improve tourist management systems, and develop specific tourist talents, inter-industry tourism sector integration needs to be promoted. This study found that China's tourism industry is still in its initial developmental stages and therefore further government assistance and guidance is needed to expedite further innovations.

Disclosure statement

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Appendix A

Table A1. Overall efficiencies for the Chinese provinces/municipalities/autonomous regions from 2012 to 2016.

NO	DMU	2012	2012 with Inte	2013	2013 with Inte	2014	2014 with Inte	2015	2015 with Inte	2016	2016 with Inte
1	Anhui	0.2027	0.2029	0.2027	0.2029	0.2182	0.2187	0.2536	0.2584	0.2537	0.2541
2	Beijing	0.9764	1.0000	1.0000	1.0000	1.0000	1.0000	0.9413	1.0000	0.9355	1.0000
3	Chongqing	0.2711	0.4181	0.2711	0.3883	0.2365	0.2843	0.2937	0.3191	0.3272	0.3433
4	Fujian	0.7558	0.7564	0.7558	0.7558	0.5873	0.5874	0.7245	0.7246	0.7326	0.7326
5	Gansu	0.2511	0.3207	0.2511	0.2984	0.2360	0.2637	0.2588	0.2758	0.2808	0.2964
6	Guangdong	0.4561	0.4702	0.4561	0.4691	0.4275	0.4426	0.4703	0.4858	0.4795	0.4864
7	Guangxi	0.3017	0.3030	0.3017	0.3024	0.2673	0.2676	0.2946	0.2949	0.3051	0.3054
8	Guizhou	0.3182	0.3490	0.3182	0.3316	0.2405	0.2444	0.3319	0.3390	0.3877	0.3970
9	Hainan	0.9047	1.0000	0.9047	1.0000	0.9005	1.0000	0.9034	1.0000	0.8783	1.0000
10	Hebei	0.3026	0.3026	0.3026	0.3026	0.2963	0.2963	0.3298	0.3298	0.3269	0.3269
11	Henan	0.3271	0.3529	0.3271	0.3378	0.3014	0.3095	0.3838	0.3875	0.4108	0.4145
12	Heilongjiang	0.0982	0.1030	0.0982	0.1028	0.1130	0.1237	0.1269	0.1378	0.1179	0.1254
13	Hubei	0.2271	0.2602	0.2271	0.2470	0.2551	0.2783	0.2576	0.2775	0.2534	0.2693
14	Hunan	0.4949	0.5111	0.4949	0.5091	0.4508	0.4677	0.5354	0.5400	0.5424	0.5468
15	Inner Mongolia	0.1512	0.2250	0.1512	0.2109	0.1736	0.2582	0.1988	0.2351	0.1908	0.2220
16	Jilin	0.1736	0.1775	0.1736	0.1766	0.2012	0.2100	0.1540	0.1709	0.1509	0.1624
17	Jiangsu	0.4230	0.4331	0.4230	0.4316	0.3875	0.3913	0.4323	0.4352	0.4458	0.4484
18	Jiangxi	0.3244	0.3541	0.3244	0.3365	0.2426	0.2485	0.2990	0.3034	0.3238	0.3280
19	Liaoning	0.3169	0.3169	0.3169	0.3169	0.5853	0.5853	0.5362	0.5362	0.3665	0.3665
20	Ningxia	0.1685	0.2326	0.1685	0.2168	0.1713	0.2141	0.1769	0.1944	0.1708	0.1797
21	Qinghai	0.0998	0.1924	0.0998	0.1777	0.1078	0.1592	0.1040	0.1273	0.1080	0.1306
22	Shandong	0.6649	0.6649	0.6649	0.6649	0.7393	0.7393	0.7592	0.7592	0.7768	0.7768
23	Shanxi	0.1841	0.1853	0.1841	0.1843	0.2219	0.2219	0.2094	0.2094	0.2037	0.2037
24	Shaanxi	0.3558	0.4783	0.3558	0.4503	0.3127	0.3628	0.3232	0.3558	0.3519	0.3816
25	Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
26	Sichuan	0.4260	0.4313	0.4260	0.4302	0.4160	0.4165	0.3395	0.3397	0.3729	0.3732
27	Tianjin	0.1616	0.3849	0.1616	0.3514	0.1565	0.3593	0.1795	0.3023	0.1785	0.2689
28	Tibet	0.1087	0.4862	0.1087	0.4542	0.0941	0.3349	0.0957	0.3082	0.1029	0.2743
29	Xinjiang	0.1723	0.1885	0.1723	0.1842	0.1797	0.1941	0.1906	0.2010	0.1880	0.1953
30	Yunnan	0.2888	0.3132	0.2888	0.3068	0.2323	0.2542	0.2882	0.3088	0.3219	0.3420
31	Zhejiang	0.7218	0.7236	0.7218	0.7245	0.7285	0.7294	0.7085	0.7091	0.7462	0.7468

Source: Authors.

Table A2. Accommodation and catering employee efficiencies with and without the inclusion of the internet connections input.

	2012	2012withInte	2013	2013withInte	2014	2014withInte	2015	2015withInte	2016	2016withInte
Anhui	0.3371	0.3374	0.3371	0.3374	0.3583	0.3589	0.4045	0.4107	0.4047	0.4052
Beijing	0.9881	1.0000	1.0000	1.0000	1.0000	1.0000	0.9698	1.0000	0.9667	1.0000
Chongqing	0.4265	0.3959	0.4265	0.4043	0.3825	0.3971	0.4540	0.4839	0.4931	0.5112
Fujian	0.8609	0.8613	0.8609	0.8609	0.7400	0.7401	0.8402	0.8403	0.8456	0.8457
Gansu	0.4014	0.4053	0.4014	0.4120	0.3818	0.4173	0.4112	0.4324	0.4385	0.4572
Guangdong	0.6264	0.6397	0.6264	0.6386	0.5989	0.6136	0.6398	0.6539	0.6482	0.6545
Guangxi	0.4635	0.4650	0.4635	0.4643	0.4218	0.4223	0.4551	0.4555	0.4676	0.4679
Guizhou	0.4827	0.4917	0.4827	0.4980	0.3878	0.3928	0.4984	0.5064	0.5588	0.5684
Hainan	0.9500	1.0000	0.9500	1.0000	0.9476	1.0000	0.9492	1.0000	0.9352	1.0000
Hebei	0.4646	0.4646	0.4646	0.4646	0.4572	0.4572	0.4960	0.4960	0.4927	0.4927
Henan	0.4930	0.5007	0.4930	0.5050	0.4632	0.4727	0.5547	0.5586	0.5824	0.5860
Heilongjiang	0.1789	0.1868	0.1789	0.1864	0.2030	0.2202	0.2251	0.2422	0.2109	0.2228
Hubei	0.3701	0.3774	0.3701	0.3813	0.4065	0.4354	0.4097	0.4344	0.4044	0.4244
Hunan	0.6621	0.6764	0.6621	0.6747	0.6215	0.6373	0.6974	0.7013	0.7033	0.7070
Inner Mongolia	0.2628	0.2652	0.2628	0.2681	0.2958	0.3158	0.3316	0.3628	0.3204	0.3453
Jilin	0.2958	0.3015	0.2958	0.3002	0.3350	0.3471	0.2669	0.2919	0.2623	0.2794
Jiangsu	0.5945	0.6045	0.5945	0.6029	0.5586	0.5624	0.6037	0.6064	0.6166	0.6192
Jiangxi	0.4899	0.4970	0.4899	0.5035	0.3905	0.3981	0.4603	0.4655	0.4892	0.4940
Liaoning	0.4813	0.4813	0.4813	0.4813	0.7384	0.7384	0.6981	0.6981	0.5364	0.5364
Ningxia	0.2884	0.2892	0.2884	0.2929	0.2925	0.3163	0.3006	0.3256	0.2917	0.3047
Qinghai	0.1815	0.1788	0.1815	0.1809	0.1946	0.1985	0.1884	0.1998	0.1950	0.2101
Shandong	0.7987	0.7987	0.7987	0.7987	0.8501	0.8501	0.8631	0.8631	0.8744	0.8744
Shanxi	0.3109	0.3127	0.3109	0.3112	0.3633	0.3633	0.3462	0.3462	0.3384	0.3384
Shaanxi	0.5248	0.5098	0.5248	0.5194	0.4764	0.5166	0.4885	0.5249	0.5206	0.5524
Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sichuan	0.5975	0.6027	0.5975	0.6016	0.5876	0.5881	0.5069	0.5072	0.5433	0.5435
Tianjin	0.2782	0.2392	0.2782	0.2874	0.2707	0.3371	0.3044	0.3693	0.3030	0.3642
Tibet	0.1961	0.1681	0.1961	0.1714	0.1719	0.1565	0.1747	0.1615	0.1866	0.1884
Xinjiang	0.2940	0.3053	0.2940	0.3064	0.3047	0.3251	0.3202	0.3347	0.3165	0.3267
Yunnan	0.4482	0.4674	0.4482	0.4696	0.3771	0.4054	0.4474	0.4719	0.4870	0.5097
Zhejiang	0.8385	0.8396	0.8385	0.8402	0.8429	0.8436	0.8294	0.8298	0.8546	0.8550

Source: Authors.

Table A3. Internet connections input efficiencies.

	2012	2013	2014	2015	2016	Average	Ranking
Anhui	0.3187	0.3175	0.1929	0.4107	0.3838	0.3247	25
Beijing	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Chongqing	0.5897	0.5594	0.4428	0.4839	0.5112	0.5174	10
Fujian	0.8613	0.8392	0.6578	0.6946	0.6252	0.7356	4
Gansu	0.4856	0.4596	0.4173	0.4324	0.3611	0.4312	19
Guangdong	0.6397	0.6386	0.6136	0.6539	0.6545	0.6400	7
Guangxi	0.4650	0.4643	0.3784	0.3756	0.3385	0.4044	22
Guizhou	0.5174	0.4980	0.3323	0.4191	0.4224	0.4378	16
Hainan	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Hebei	0.3409	0.3248	0.2922	0.2652	0.2383	0.2923	28
Henan	0.5217	0.5050	0.4727	0.4743	0.4473	0.4842	15
Heilongjiang	0.1868	0.1864	0.2202	0.2422	0.2228	0.2117	31
Hubei	0.4129	0.3961	0.4354	0.4344	0.4244	0.4206	21
Hunan	0.6764	0.6747	0.6373	0.6813	0.6012	0.6542	6
Inner Mongolia	0.3673	0.3484	0.4104	0.3807	0.3634	0.3740	23
Jilin	0.3015	0.3002	0.3471	0.2919	0.2794	0.3040	27
Jiangsu	0.6045	0.6029	0.4678	0.4584	0.4363	0.5140	11
Jiangxi	0.5230	0.5035	0.3600	0.3970	0.3782	0.4323	18
Liaoning	0.3591	0.3524	0.5357	0.5173	0.3870	0.4303	20
Ningxia	0.3774	0.3564	0.3527	0.3256	0.3047	0.3433	24
Qinghai	0.3227	0.3018	0.2746	0.2258	0.2310	0.2712	30
Shandong	0.5362	0.5369	0.4719	0.4462	0.4431	0.4869	14
Shanxi	0.3127	0.3112	0.3133	0.2734	0.2456	0.2912	29
Shaanxi	0.6471	0.6210	0.5325	0.5249	0.5524	0.5756	8
Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Sichuan	0.6027	0.6016	0.4329	0.4178	0.4114	0.4933	13
Tianjin	0.5558	0.5201	0.5287	0.4643	0.4239	0.4985	12
Tibet	0.6543	0.6246	0.5017	0.4712	0.4306	0.5365	9
Xinjiang	0.3172	0.3110	0.3251	0.3347	0.3177	0.3212	26
Yunnan	0.4770	0.4696	0.4054	0.4105	0.4132	0.4351	17
Zhejiang	0.8396	0.8402	0.6236	0.6055	0.5871	0.6992	5

Source: Authors.

Table A4. Accommodation revenue efficiencies and rankings with and without the inclusion of the internet connections input.

	2012	2013	2014	2015	2016	Average	Rank	2012withInte	2013withInte	2014withInte	2015withInte	2016withIntenet	Average	Rank
Anhui	0.5884	0.5884	0.5987	0.5964	0.5934	0.5931	29	0.5885	0.5885	0.5986	0.5961	0.5935	0.5930	29
Beijing	0.9884	1.0000	1.0000	0.9715	0.9688	0.9857	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Chongqing	0.6116	0.6116	0.6278	0.6153	0.6122	0.6157	23	0.6267	0.6233	0.6209	0.6137	0.6141	0.6198	23
Fujian	0.6127	0.6127	0.6321	0.6263	0.6205	0.6209	22	0.6127	0.6127	0.6321	0.6263	0.6205	0.6209	22
Gansu	0.6638	0.6638	0.6687	0.6614	0.6552	0.6626	10	0.6804	0.6762	0.6590	0.6607	0.6615	0.6675	10
Guangdong	0.6689	0.6689	0.7050	0.6954	0.6854	0.6847	8	0.6696	0.6696	0.6985	0.6953	0.6872	0.6840	8
Guangxi	0.6826	0.6826	0.6784	0.6880	0.6822	0.6827	9	0.6826	0.6826	0.6783	0.6880	0.6823	0.6828	9
Guizhou	0.7163	0.7163	0.7248	0.7496	0.7427	0.7299	4	0.7229	0.7188	0.7258	0.7516	0.7480	0.7334	5
Hainan	0.9132	0.9132	0.9526	0.9539	0.9065	0.9279	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Hebei	0.5786	0.5786	0.5904	0.5833	0.5774	0.5817	31	0.5786	0.5786	0.5904	0.5833	0.5774	0.5817	31
Henan	0.6212	0.6212	0.6316	0.6381	0.6311	0.6286	18	0.6229	0.6213	0.6290	0.6382	0.6320	0.6287	18
Heilongjiang	0.6361	0.6361	0.6568	0.6456	0.6354	0.6420	14	0.6375	0.6376	0.6430	0.6422	0.6381	0.6397	14
Hubei	0.6202	0.6202	0.6310	0.6308	0.6202	0.6245	20	0.6246	0.6230	0.6216	0.6293	0.6235	0.6244	20
Hunan	0.6230	0.6230	0.6417	0.6396	0.6286	0.6312	15	0.6236	0.6235	0.6374	0.6397	0.6295	0.6307	15
Inner Mongolia	0.5836	0.5836	0.5874	0.5861	0.5851	0.5852	30	0.5926	0.5913	0.5851	0.5854	0.5901	0.5889	30
Jilin	0.6068	0.6068	0.5966	0.5907	0.5925	0.5987	26	0.6072	0.6073	0.5928	0.5882	0.5939	0.5979	26
Jiangsu	0.5970	0.5970	0.6042	0.6050	0.5980	0.6002	25	0.5972	0.5972	0.6040	0.6050	0.5984	0.6004	25
Jiangxi	0.6127	0.6127	0.6381	0.6255	0.6169	0.6212	21	0.6149	0.6130	0.6369	0.6254	0.6180	0.6217	21
Liaoning	0.6242	0.6242	0.6449	0.6245	0.6263	0.6288	16	0.6242	0.6242	0.6449	0.6245	0.6263	0.6288	16
Ningxia	0.5877	0.5877	0.6045	0.6013	0.5925	0.5947	28	0.5946	0.5932	0.5980	0.5994	0.5952	0.5961	27
Qinghai	0.6858	0.6858	0.6915	0.6906	0.6726	0.6853	7	0.7124	0.7087	0.6957	0.6962	0.6818	0.6989	7
Shandong	0.6284	0.6284	0.6337	0.6302	0.6231	0.6287	17	0.6284	0.6284	0.6337	0.6302	0.6231	0.6287	17
Shanxi	0.5885	0.5885	0.6051	0.6036	0.5917	0.5955	27	0.5884	0.5885	0.6051	0.6036	0.5917	0.5955	28
Shaanxi	0.5999	0.5999	0.6143	0.6099	0.6008	0.6050	24	0.6126	0.6099	0.6073	0.6091	0.6054	0.6089	24
Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Sichuan	0.6361	0.6361	0.6781	0.6417	0.6284	0.6441	13	0.6360	0.6360	0.6780	0.6417	0.6285	0.6441	13
Tianjin	0.6587	0.6587	0.6803	0.6529	0.6421	0.6585	11	0.7013	0.6583	0.6339	0.6296	0.6241	0.6494	11
Tibet	0.6917	0.6917	0.6882	0.6886	0.6903	0.6901	6	0.7956	0.7856	0.7504	0.7430	0.7338	0.7617	4
Xinjiang	0.6360	0.6360	0.6188	0.6223	0.6272	0.6281	19	0.6396	0.6390	0.6131	0.6213	0.6303	0.6287	19
Yunnan	0.6912	0.6912	0.7226	0.7272	0.7140	0.7092	5	0.7003	0.6989	0.7168	0.7266	0.7252	0.7136	6
Zhejiang	0.6646	0.6646	0.6448	0.6408	0.6308	0.6491	12	0.6647	0.6648	0.6448	0.6409	0.6309	0.6492	12

Source: Authors.

Table A5. Food Service revenue efficiencies and rankings with and without the inclusion of the internet connections input.

	2012	2013	2014	2015	2016	Average	Rank	2012withInte	2013withInte	2014withInte	2015withInte	2016withInte	Average	Rank
Anhui	0.7150	0.7150	0.7190	0.7282	0.7282	0.7211	22	0.7150	0.7150	0.7191	0.7295	0.7284	0.7214	21
Beijing	0.9801	1.0000	1.0000	0.9389	0.9686	0.9775	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Chongqing	0.7329	0.7329	0.7237	0.7390	0.7483	0.7354	19	0.7746	0.7658	0.7365	0.7460	0.7528	0.7551	12
Fujian	0.8912	0.8912	0.8290	0.8789	0.8821	0.8745	6	0.8914	0.8912	0.8290	0.8790	0.8821	0.8745	4
Gansu	0.7276	0.7276	0.7236	0.7296	0.7355	0.7288	20	0.7465	0.7403	0.7309	0.7342	0.7397	0.7383	18
Guangdong	0.7862	0.7862	0.7775	0.7906	0.7935	0.7868	8	0.7906	0.7902	0.7820	0.7955	0.7957	0.7908	6
Guangxi	0.7412	0.7412	0.7319	0.7393	0.7421	0.7391	17	0.7416	0.7414	0.7320	0.7393	0.7422	0.7393	17
Guizhou	0.7458	0.7458	0.7082	0.7386	0.7656	0.7408	16	0.7544	0.7495	0.7258	0.7430	0.7684	0.7482	13
Hainan	0.9545	0.9545	0.8763	0.9245	0.9427	0.9305	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Hebei	0.7415	0.7415	0.7397	0.7490	0.7482	0.7440	14	0.7415	0.7415	0.7397	0.7490	0.7482	0.7440	15
Henan	0.7483	0.7483	0.7411	0.7645	0.7725	0.7549	12	0.7555	0.7512	0.7434	0.7656	0.7735	0.7578	11
Heilongjiang	0.6892	0.6892	0.6928	0.6961	0.6939	0.6923	29	0.6904	0.6903	0.6953	0.6988	0.6957	0.6941	28
Hubei	0.7213	0.7213	0.7286	0.7293	0.7282	0.7257	21	0.7300	0.7265	0.7348	0.7346	0.7324	0.7317	19
Hunan	0.7984	0.7984	0.7846	0.8115	0.8138	0.8013	7	0.8036	0.8029	0.7898	0.8130	0.8153	0.8049	5
Inner Mongolia	0.7021	0.7021	0.7076	0.7140	0.7119	0.7075	25	0.7207	0.7171	0.7294	0.7234	0.7199	0.7221	20
Jilin	0.7076	0.7076	0.7146	0.7027	0.7020	0.7069	27	0.7086	0.7084	0.7168	0.7069	0.7048	0.7091	25
Jiangsu	0.7761	0.7761	0.7656	0.7789	0.7830	0.7759	10	0.7792	0.7787	0.7667	0.7798	0.7838	0.7776	8
Jiangxi	0.7475	0.7475	0.7253	0.7405	0.7473	0.7416	15	0.7559	0.7509	0.7269	0.7417	0.7485	0.7448	14
Liaoning	0.7454	0.7454	0.8283	0.8118	0.7594	0.7781	9	0.7454	0.7454	0.8283	0.8118	0.7594	0.7781	7
Ningxia	0.7063	0.7063	0.7070	0.7084	0.7069	0.7070	26	0.7227	0.7186	0.7179	0.7129	0.7092	0.7162	22
Qinghai	0.6896	0.6896	0.6762	0.6798	0.6916	0.6854	30	0.7116	0.7080	0.7040	0.6948	0.6970	0.7031	26
Shandong	0.8565	0.8565	0.8847	0.8925	0.8996	0.8779	5	0.8565	0.8565	0.8847	0.8925	0.8996	0.8779	3
Shanxi	0.7102	0.7102	0.7199	0.7167	0.7152	0.7145	23	0.7106	0.7103	0.7199	0.7167	0.7152	0.7145	23
Shaanxi	0.7564	0.7564	0.7442	0.7471	0.7553	0.7519	13	0.7931	0.7844	0.7584	0.7564	0.7638	0.7712	9
Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Sichuan	0.7770	0.7770	0.7740	0.7517	0.7613	0.7682	11	0.7786	0.7783	0.7742	0.7518	0.7614	0.7688	10
Tianjin	0.7046	0.7046	0.7034	0.7091	0.7089	0.7061	28	0.7648	0.7059	0.6670	0.6842	0.6794	0.7003	27
Tibet	0.6338	0.6338	0.6220	0.6428	0.6501	0.6365	31	0.6853	0.6802	0.6762	0.6895	0.6731	0.6809	29
Xinjiang	0.7073	0.7073	0.7091	0.7119	0.7112	0.7094	24	0.7114	0.7103	0.7128	0.7145	0.7131	0.7124	24
Yunnan	0.7377	0.7377	0.7206	0.7375	0.7468	0.7361	18	0.7444	0.7426	0.7284	0.7432	0.7525	0.7422	16
Zhejiang	0.8779	0.8779	0.8805	0.8728	0.8874	0.8793	4	0.8786	0.8789	0.8808	0.8730	0.8876	0.8798	2

Source: Authors.

Table A6. Catering revenue efficiencies and rankings with and without the inclusion of the internet connections input.

DMU	2012	2013	2014	2015	2016	Average	rank	2012withInternet	2013withInternet	2014withInternet	2015withInternet	2016withInternet	Average	rank
Anhui	0.5833	0.5833	0.5719	0.5728	0.5818	0.5786	10	0.5845	0.5845	0.5727	0.5777	0.5829	0.5805	17
Beijing	0.7646	1.0000	1.0000	0.7627	0.7669	0.8588	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1
Chongqing	0.6271	0.6271	0.6446	0.6399	0.6449	0.6367	4	0.7461	0.7375	0.7365	0.7064	0.7012	0.7255	5
Fujian	0.5571	0.5571	0.5578	0.5545	0.5590	0.5571	15	0.5576	0.5571	0.5578	0.5545	0.5590	0.5572	23
Gansu	0.5397	0.5397	0.5452	0.5449	0.5418	0.5423	19	0.6215	0.6166	0.5988	0.5844	0.5729	0.5988	11
Guangdong	0.5889	0.5889	0.5961	0.5996	0.5945	0.5936	6	0.6321	0.6270	0.6147	0.6169	0.6051	0.6192	9
Guangxi	0.5321	0.5321	0.5300	0.5325	0.5324	0.5318	25	0.5334	0.5328	0.5302	0.5328	0.5326	0.5324	30
Guizhou	0.5311	0.5311	0.5333	0.5313	0.5346	0.5323	24	0.5528	0.5519	0.5531	0.5400	0.5426	0.5481	25
Hainan	0.5068	0.5068	0.5065	0.5053	0.5064	0.5064	30	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2
Hebei	0.5221	0.5221	0.5266	0.5223	0.5218	0.5230	27	0.5221	0.5221	0.5266	0.5223	0.5218	0.5230	31
Henan	0.5375	0.5375	0.5543	0.5531	0.5513	0.5468	17	0.5574	0.5545	0.5617	0.5574	0.5552	0.5572	22
Heilongjiang	0.5169	0.5169	0.5317	0.5217	0.5200	0.5214	28	0.5312	0.5299	0.5515	0.5330	0.5308	0.5353	28
Hubei	0.6075	0.6075	0.6160	0.6313	0.6150	0.6155	5	0.7300	0.7253	0.7027	0.7188	0.6966	0.7147	6
Hunan	0.5410	0.5410	0.5405	0.5440	0.5453	0.5424	18	0.5599	0.5568	0.5480	0.5471	0.5485	0.5521	24
Inner Mongolia	0.5500	0.5500	0.5581	0.5592	0.5617	0.5558	16	0.7188	0.7102	0.6770	0.6923	0.7199	0.7037	7
Jilin	0.5378	0.5378	0.5269	0.5364	0.5360	0.5350	22	0.5490	0.5460	0.5326	0.5542	0.5552	0.5474	26
Jiangsu	0.5766	0.5766	0.5935	0.5891	0.5829	0.5837	9	0.6018	0.5970	0.5986	0.5941	0.5874	0.5958	12
Jiangxi	0.5270	0.5270	0.5325	0.5537	0.5305	0.5341	23	0.5421	0.5414	0.5369	0.5604	0.5339	0.5429	27
Liaoning	0.5816	0.5816	0.5819	0.5703	0.5697	0.5770	11	0.5816	0.5816	0.5819	0.5703	0.5697	0.5770	18
Ningxia	0.5301	0.5301	0.5397	0.5414	0.5367	0.5356	21	0.5719	0.5702	0.5827	0.5825	0.5605	0.5736	19
Qinghai	0.5275	0.5275	0.5258	0.5384	0.5357	0.5310	26	0.5814	0.5793	0.5652	0.6081	0.5918	0.5851	16
Shandong	0.5725	0.5725	0.6016	0.5939	0.5871	0.5855	7	0.5725	0.5725	0.6016	0.5939	0.5871	0.5855	15
Shanxi	0.5575	0.5575	0.5685	0.5689	0.5672	0.5639	13	0.5616	0.5582	0.5685	0.5689	0.5672	0.5649	20
Shaanxi	0.5638	0.5638	0.5626	0.5681	0.5665	0.5649	12	0.6796	0.6722	0.6476	0.6548	0.6499	0.6608	8
Shanghai	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	3
Sichuan	0.5741	0.5741	0.6070	0.5887	0.5779	0.5843	8	0.5851	0.5826	0.6078	0.5893	0.5783	0.5886	14
Tianjin	0.6463	0.6463	0.7012	0.6690	0.6585	0.6643	3	0.7648	0.7551	0.7574	0.7414	0.7323	0.7502	4
Tibet	0.5055	0.5055	0.5050	0.5038	0.5059	0.5051	31	0.5883	0.5735	0.7504	0.6062	0.5417	0.6120	10
Xinjiang	0.5217	0.5217	0.5185	0.5211	0.5204	0.5207	29	0.5437	0.5434	0.5280	0.5309	0.5285	0.5349	29
Yunnan	0.5387	0.5387	0.5469	0.5409	0.5415	0.5414	20	0.6016	0.6006	0.6005	0.5873	0.5808	0.5942	13
Zhejiang	0.5631	0.5631	0.5614	0.5627	0.5620	0.5625	14	0.5648	0.5656	0.5618	0.5632	0.5624	0.5635	21

Source: Authors.