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Hotel performance in the Guangdong-Hong Kong-Macau Greater Bay Area: A non-homogeneous perspective

Highlights:

- Higher level of product diversification is related to better performance
- F&B exerted a more pronounced influence on overall hotel performance
- Hotels in GBA could benchmark Zhongshan for rooms, Macau for F&B, Hong Kong for meeting services, and Shenzhen for spa services

Abstract:

Improving upon previous studies on hotel performance evaluation in terms of efficiency, which usually treat different hotels as homogeneous in their product provision, this study examines the performance of 53 hotels in the Guangdong-Hong Kong-Macau Greater Bay Area (GBA) during 2015-2019 by employing data envelopment analysis with a non-homogeneous decision making units (DMUs) model. The results show that the hotels in GBA were inefficient, and those with high product diversification are generally closer to achieving optimal efficiency levels, particularly those providing rooms, food and beverage, meeting services, and spa services, while those providing only rooms had the worst performance. Among the GBA cities included in this study, the non-homogeneous efficiency scores of the hotels in Guangzhou outperformed those of hotels in the other cities, and the overall hotel efficiency score of the core cities was better than that of the key node cities.

Keywords: Product diversification, non-homogeneous DMUs, DEA, Hotel efficiency, Greater Bay Area

1. Introduction

The Guangdong-Hong Kong-Macau Greater Bay Area (GBA), comprising the cities of Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing in Guangdong Province, as well as Hong Kong and Macau, was formed with an aim of deepening cooperation and development, including tourism, among Guangdong province, Hong Kong and Macau (GBA Plan, 2019), and has seen great economic development over the years. In terms of economic aggregate and population size, GBA produced USD 1,668.8 billion in GDP with a total population of more than 86 million in

2020 (GBA, 2022); in terms of tourism, GBA is among those regions with a high degree of openness and strong economic vitality in China (GBA Plan, 2019). In particular, from 2015 to 2019, the number of hotels in GBA increased by 11% from 9,953 to 11,073; Huizhou, Shenzhen, and Zhuhai were the top three cities in injecting new hotel guestroom supply, with a total of 80,702 rooms added and Huizhou alone increasing its number of hotel rooms by 80% (HKTB, 2019; MGTO, 2015 & 2019; Statistics Bureau of Guangdong Province, 2016 & 2020). Such increases in hotel supply have made the hotel industry increasingly competitive (Fan et al., 2022), and the competition will only become more intense in the future, especially with ease of access among GBA cities due to the Hong Kong-Zhuhai-Macau Bridge and the Guangzhou-Shenzhen-Hong Kong Express Rail Link, which have made it more convenient for tourists to visit and move around GBA. Disparities in economic development, customer demographics, urban characteristics, and competitive landscapes among these cities result in substantial variations in hotel operating income (Lado-Sestayo & Vivel-Bua, 2018; Dong et al., 2020). Arbelo et al. (2021) observed that, propelled by fierce competition, hotels tend to develop diverse resources, providing a range of services to optimize performance. Consequently, the diversity of hotel service output becomes notably pronounced. Accurate measurement of hotel performance in terms of efficiency can help hotels in GBA gain competitiveness, identify issues associated with resource allocation, and guide managers to formulate strategies to optimize hotel operation (Kim & Chung, 2020; Tan & Despotis, 2021).

While a number of studies on hotel performance evaluation offer decision making cues for hotel managers (e.g., Liu et al., 2018; Pérez-Rodríguez & Acosta-González, 2021), others employing such techniques as data envelopment analysis (DEA) are often carried out under the assumption of homogeneity among hotels (Arbelo et al., 2021). That is, it is assumed that hotels under evaluation have the same output. Nevertheless, in practice such an assumption is not warranted (Cook et al., 2012). Hotel revenue can originate from various sources, including rooms, catering, and meeting services and so on. Previous scholars calculated efficiency by aggregating the revenue from all services as the total output of hotels, neglecting the distinction in income sources. This approach may obscure important information and lead to inaccurate performance evaluations. As pointed out by Benur and Bramwell (2015), product diversification should be taken into account, as it improves the competitiveness and sustainable development of a hotel. In reality, hotels do not universally offer identical products. For example, some hotels provide spa services targeting higher-end or leisure clientele, while others boast convention and meeting facilities to cater to corporate customers. The presence of product diversification introduces variations in hotel operations; ignoring this aspect can render hotel performance evaluation impractial and introduce bias into management decision-making. As highlighted by Corne (2015), in situations where heterogeneity arises—for example, when hotels with different star ratings may have different effective boundaries—it is crucial to measure them separately.

As such, it is obviously not ideal to mix hotels offering different products for performance evaluation. When measuring hotel performance in terms of efficiency, non-homogeneous factors should be considered to better and more accurately distinguish better-performing units from under-performing ones on a fair basis. However, only a few scholars have paid attention to the heterogeneity of hotels when assessing their efficiency, mainly focusing on scale, location, and ownership (Assaf & Tsionas, 2018; Pérez-Rodríguez & Acosta-González, 2021), rather than product diversification. To date, to our best knowledge no study has considered the non-homogeneity of hotels to evaluate hotel performance in terms of efficiency more fairly.

Given the intense competition among tourist destinations, this study aims to evaluate on a fairer basis the efficiency performance of hotels in GBA. 53 sample hotels in GBA were treated as multi-activity decision entities, taking into account their provision of rooms, food and beverage (F&B), meeting services, and spa services to distinguish the product diversification existing among hotels. We then improved the DEA model with non-homogeneous decision making units (DMUs) (Cook et al., 2013) and limit the distribution input ratio using the income ratio relationship of various services. This methodology offers a means to establish both upper and lower bounds for the distribution ratio, lending practical significance to the approach. We last applied the model using the data from sample hotels that offer diverse products, thus providing empirical evidence for the practical application of this method in hotels. For hotel groups with different degrees of product diversification and with different geographical locations, we analyzed the results of hotel performance in terms of efficiency, identified different problems of hotels with different characteristics, and put forward targeted suggestions to enhance the competitiveness of hotels in GBA.

The rest of the paper is organized as follows. The next section reviews prior literature, and is followed by the methodology, data, and empirical results sections. The implications of the study are then provided. Finally, we conclude the study and explain the study's limitations.

2. Literature Review

2.1 Product diversification in the hotel industry

Diversification is a key strategy for improving profitability (Rumelt, 1982). It can help hotels gain competitive advantages and reduce failure rate (Lin & Kim, 2020) by allowing them to develop surplus assets and share resources such as brand, customer loyalty, and managerial expertise (George & Kabir, 2012). Previous research has studied diversification in the hotel industry from different perspectives, such as brand diversification (Koh, 2019), geographic diversification (Song & Kang, 2019), market segment diversification (DeFranco et al., 2022), and product diversification (Yang et al., 2017). Compared to other types of diversification strategies, product diversification, referring to the expansion of a company into new product markets (Hitt et al., 1994), offers a tangible cue for a hotel to stand out from its peers.

As a strategy for tackling fierce competition, hotels normally seek to diversify their products to cater to the needs and expectations of different customers (Yin et al., 2020). Beyond mere accommodation, contemporary hotels tend to provide a wider range of products in areas including catering, bar, conference, spa, casino, and retail, among others. Hotels with diverse products may not only enjoy improved customer satisfaction and loyalty (Pan & Nguyen, 2015) but also become preferred choices for consumers when choosing a hotel (Kim & Chung, 2020). Besides, accommodation services have an externality of demand, which can trigger other sorts of demand for products, such as hotel restaurants and spas, where a large amount of business comes from hotel guests (Yang et al., 2017). By diversifying products, hotels can generate economies of scale and scope, thus reducing costs and improving performance (Tan & Despotis, 2021).

Few existing studies have examined the relationship between product diversification and firm performance, and the results show that product diversification may have an irrelevant (Delios & Beamish, 1999), positive (Chang & Wang, 2007), or inverse U-shaped (Kang et al., 2011) relationship with firm performance; however, only a handful of studies related to hotel product diversification exist. For instance, Yeh et al. (2012) found that international tourist hotels in Taiwan tend to diversify their products by expanding their F&B services. Yang et al. (2017) analyzed 377 urban hotels in Beijing, China, and discovered that the degree of product diversification was positively correlated with hotel performance. Walheer and Zhang (2018) explored star-rated hotels in 30 provinces of China and concluded that the hotels' diversification processes revealed their profit maximization intentions.

While product diversification appears to benefit hotels, its degree may vary from hotel to hotel, leading to non-homogeneity among hotels when it comes to product provision. That is, some hotels may offer different levels and types of spa services, while others provide a wide range of conference facilities and other forms of products to meet various market demands

(Gu et al., 2012). Research on hotel firm performance ought to consider the issue of non-homogeneity of hotels so as to understand better whether product diversification may make a difference when firm performance is assessed.

2.2 Hotel efficiency evaluation

Efficiency serves as a crucial measure for maximizing operational utility, reflecting performance levels given available resources and industry characteristics (Kim et al., 2022; Parte-Esteban & Alberca-Oliver, 2015). It is closely tied to goal setting, performance monitoring and product operation management (Assaf & Magnini, 2012). Assessing a hotel's efficiency provides insights into resource allocation, offering ideas for optimizing operations and reducing costs, making it particularly significant (Tan & Despotis, 2021). DEA, a non-parametric efficiency measurement method, is widely employed in hotel efficiency evaluation due to its ability to assess relative efficiency without pre-determining a production function, distinguishing it from methods like stochastic frontier analysis (Lozano, 2012; Yin et al., 2020; Wen et al., 2021).

More specifically, leveraging economic production theory, when all decision variables share the same input-output index, the DEA model adeptly address multi-input-output situations without requiring specific function forms (Puertas et al., 2022). DEA assigns weights to production and output indicators of DMUs using a linear programming method, aligning with the structural characteristics of the data. This approach overcomes the limitation of subjectively assigning weights using the parametric method. The data-oriented DEA model ensures a balanced and impartial perspective, facilitating a scientific and objective measurement of productivity (Zhu, 2022). In view of the advantages of DEA in efficiency assessment, many research studies have put forward various DEA methods to evaluate hotel efficiency more effectively, such as hybrid DEA (Huang, 2017), network DEA (Kim & Chung, 2020; Tan & Despotis, 2021; Yin et al., 2020), and Malmquist-Luenberger index (Chen, 2019). For example, Huang et al. (2016) utilized a hybrid DEA model to assess the impact of labor on operational efficiency in hotels. Tan and Despotis (2021) employed a network DEA technique to evaluate the efficacy of the hospitality industry in the UK. These DEA methods are frequently employed to assess the relative efficiency of a group of homogeneous DMUs (Zhu et al., 2018). Unfortunately, in practice, not all DMUs are homogeneous. According to the resource-based view, hotels possessing varying operational resources and capabilities ought to be treated as non-homogeneous entities, particularly in efficiency assessment (Assaf et al., 2010). Therefore, internal attributes of a hotel such as size, technology adoption, class, etc. may be considered in the evaluation of its efficiency.

Some studies have considered resource heterogeneity. Arbelo et al. (2021) regarded 461 Spanish hotels as heterogeneous units and applied a random-effect Bayesian frontier model to estimate the profit efficiency of each hotel. The results showed that in order to maximize their efficiency, the hotels tended to deploy strategies based on heterogeneous resources they had. On the basis of hotel categories, Corne (2015) adopted a hierarchical category DEA to evaluate the relative efficiency of a sample of mid-price, economy, and budget French hotels, and found that the budget ones were more efficient than those in the other categories. In terms of technology heterogeneity, Arbelo-Pérez et al. (2020) applied a stochastic frontier model with stochastic coefficients to a sample of 101 Spanish hotels from 2010 to 2014 and found that technology heterogeneity among different hotels could significantly affect their revenue output. Taking into account ownership and scale, Pérez-Rodríguez and Acosta-González (2021) used a metafrontier approach to analyze hotel efficiency in the Canary Islands, Spain and found that large hotels were more efficient than small ones, and that efficiency performance was independent of the type of ownership. Yu and Chen (2016) adopted a metafrontier Malmquist productivity index to evaluate the operating performance of chain and independent hotels in Taiwan from 2008 to 2011 and found that chain hotels had more advanced technology than independent hotels. The aforementioned studies focus on external heterogeneity, neglecting internal heterogeneity. In contrast, this paper prioritizes internal heterogeneity, marking it as the inaugural exploration of variations within internal production structures.

In summary, to the best of our knowledge, no hotel efficiency studies have considered the factor of product diversification, despite its practical existence. While Cook et al. (2013) primarily explored the variability of inputs and outputs in the industrial sector, whether similar conclusions could be reached in the context of hotel efficiency remain uncertain. It is evident that prior studies have not considered output diversification when evaluating hotel efficiency. Our study aims to fill this research void.

3. Methodology

3.1 DEA with non-homogeneous DMUs

The core principle of the DEA method is to compare production units with similar capabilities. A linear programming approach is employed to assign weights to the production and output indicators of DMUs, thereby constructing an efficient production frontier. Points situated on this frontier are considered to have a technical efficiency of 100%. Using the technical efficiency derived from the production frontier, the efficiency values of all production units are measured, enabling the comparison of efficiency values across different DMUs. As an efficiency evaluation tool, DEA has been widely employed in various industries such as tourism (Zha et al., 2022), restaurant (Alberca & Parte, 2018), high-tech (Yu et al., 2021), etc. to assess the relative efficiency of a set of homogeneous DMUs (Wen et al., 2021). The technique, initially introduced by Charnes et al. (1978) and termed CCR-DEA, is presented as follows:

$$
\begin{aligned}
& e_0^* = \max \sum_r \mu_r y_{rj_0} / \sum_i \nu_i x_{ij_0} \\
& s.t. \ \ \sum_r \mu_r y_{rj} / \sum_i \nu_i x_{ij} \le 1, \qquad j = 1, \ldots, n \\
& \qquad \mu_r, \nu_i \ge 0, \qquad\qquad\qquad\quad \forall r, i
\end{aligned} \tag{1}
$$

In model (1), there are n DMUs, denoted as DMU_j, and each DMU uses I different inputs x_{ij} to produce R different outputs y_{rj}. The optimal result of model (1) is an efficiency score of any given DMU (i.e., DMU_{j_0}) where μ_r and ν_i are the weight for each output and input variable, respectively. DMU_{j_0} is considered efficient if and only if the efficiency score e_0^* is equal to one. If DMU_{j_0} has an efficiency score less than one, the difference between its efficiency score and one represents the extent to which it falls short of achieving operational efficiency.

However, the conventional DEA method mentioned above cannot deal with the problem of hotel efficiency evaluation with product diversification. Therefore, making reference to Cook et al. (2013), we construct a performance evaluation method which is more suitable for the hotel industry with a characteristic of product diversification.

In the non-homogeneous scenario, hotels may use the same type of resources to produce diverse products. To address this, we cluster hotels into g homogeneous groups (e.g., G_1, G_2, …, G_g) based on the diversity of their products. Each group produces the same types of output items, with distinct sets of output items for hotels in different groups. For example, hotels in homogeneous group A may output a, b, and c, while those in group B output a, b, and d. Despite the overlap in two of the three outputs, the third output differs. Assuming R output items can be organized into Q disjoint subgroups (R_1, R_2, …, R_q), let L_{G_g} denote those R_q forming the full output set for any DMU in G_g (Cook et al., 2013). Based on this, we derive the efficiency scores of each individual hotel through the three steps described below.

First, we split the shared inputs to the output subgroups [model (5) in Appendix D]. Variable β_{iR_qg} is used to denote the proportion of input x_{ij} that will be allocated to output subgroup $R_q \in L_{G_g}$. In a heterogeneous scenario, the optimal way to allocate resources is by determining the most suitable weight β_{iR_qg} to achieve the highest efficiency score for the output subgroup (the detailed calculation of β_{iR_qg} is included in the model (5) of Appendix D). Second, we evaluate the efficiency score of each subgroup R_q using model (6) as outlined in Appendix D. The optimal input proportions are determined from model (5) as described in the first step. In the final step, we calculate the non-homogeneous efficiency score E_0 of DMU_{j_0} using model (7) (in Appendix D). This involves computing a weighted average of the subgroup efficiency scores obtained in the second step, using $W_{R_qj_0}$ as defined in model (3) from Appendix D. The efficiency value of each subgroup is also derived through model (7).

Two points are noted. First, referring to Mahajan et al. (2023) and Karakitsiou et al. (2020), the hotel grapples with inefficient management of human resources and unnecessary expenditure, areas demanding substantial improvement. The input-oriented DEA model identify surplus resources in inefficient units, allowing for the reallocation of existing resources. This method aims to enhance overall productivity and efficiency by redirecting resources to where they can be most effectively utilized. Secondly, the CCR model is selected to maintain scale payoff invariance, and the scale of hotel operations is not likely to change in the short term. For instance, the number of rooms, meeting rooms, area, etc., will remain constant once the hotel is in operation, at least in the short term. Therefore, taking this scale invariance factor into account, we opt for the CCR model, which is more suitable. (Fancello et al., 2020).

3.2 Variable selection and data

When applying DEA to measure efficiency, it is critical to select appropriate input and output variables (Tsaur, 2001). Based on previous studies (Lado-Sestayo & Fernández-Castro, 2019; Liu et al., 2018), we selected three input variables from the perspective of labor and capital inputs, namely labor cost including salaries, wages, and benefits, operating expense including department operating expenses, administrative and general expenses, and marketing and utility expenses, and fixed costs. To reflect the diversity of hotel products, room revenue, F&B revenue, meeting room rental revenue, and spa revenue were selected as output variables.

Hotels can be considered as multi-activity decision-makers (Walheer & Zhang, 2018) because they aim to cater to various needs and expectations of customers by offering diverse products, and thus, diversification is a characteristic of the hotel industry (DeFranco et al., 2022). While accommodation normally accounts for a larger portion of revenue in hotels in western countries, F&B tends to be the main source of hotel revenue in Asian countries (Whitla et al., 2007). Chen and Chang (2012) showed that hotels where F&B service was the main source of total revenue had higher profit margin growth. Similarly, meeting services are also an important source of revenue for hotels (Boo & Busser, 2018). As the size and volume of the conference and event business grows, the main beneficiaries are hotels that provide meeting services to their customers (Madanoglu & Ozdemir, 2016). Moreover, provision of spa services has transformed from an inessential ancillary for hoteliers into an important element of hotel success (Mandelbaum & Lerner, 2008). Both leisure and business travelers are increasingly interested in spa experiences, and spa treatments can be an important factor in their booking decisions (Lo & Wu, 2014). Thus, we considered rooms, F&B, meeting services, and spa services as the main types of products offered by hotels. Table 1 shows the input and output variables involved in the modeling of this study.

Table 1 Input and output variables

Type	Variable	Unit
Inputs	Labor costs	Million HKD
	Operating expense	Million HKD
	Fixed costs	Million HKD
Outputs	Room revenue	Million HKD
	F&B revenue	Million HKD
	Meeting room rental revenue	Million HKD
	Spa revenue	Million HKD

We obtained requisite data from STR Global, a global company providing hotel operational data submitted by individual hotels for the evaluation of hotel performance (Assaf

& Tsionas, 2018). It should be noted that STR does not collect data regarding fixed costs from hotels, which is a capacity-related key hotel capital input (Dong et al., 2020). Several existing studies (e.g., Assaf et al., 2010; Oukil et al., 2016) did use the number of rooms as a proxy for the fixed costs and operating expenditures for hotels, but no information on size, quality, and infrastructure of a hotel was provided (Chatzimichael & Liasidou, 2019; Huang, 2017). For example, if there are two hotels with the same number of rooms, the fixed cost input of the higher star-rated hotel will be much larger than that of the lower star-rated one. Having said the above, however, fixed assets are certainly a better measure of the investment than the number of rooms in a hotel (Tang & Jang, 2007; Walheer & Zhang, 2018). Therefore, based on the number of hotel rooms provided by STR Global and with professional input from senior executives of hospitality consultancy firms including Horwath and Huamei in mainland China (H. Wang, personal communication, December 1, 2021) regarding unit room costs among the different types of luxury hotels, upscale hotels, and so on, we estimated the fixed costs of each hotel by multiplying the number of rooms by the unit room construction cost in the region to serve as a proxy for capital input in this study. Considering data availability, we selected hotels in seven cities in GBA, namely Guangzhou, Shenzhen, Hong Kong, Macau, Foshan, Zhongshan, and Huizhou, with a total of 265 observations from 53 hotels during 2015-2019 as our sample for analysis (53 hotels × five years = 265 hotel-year observations). This is in line with the rule of thumb that the number of DMUs is twice the product of the number of inputs and the number of outputs (Cooper et al., 2011). Appendix A details the attributes of the 53 hotels in 2019.

4. Results

As expected, the 53 sample hotels in GBA provided different types of products. To contextualize our hotel efficiency analysis considering non-homogeneity of hotels in GBA, Table 2 shows the average revenue mix of the five groups of hotels (G1-G5) providing different types of products during 2015-2019. For example, G1 represents a group of hotels whose only product is rooms, while G2 represents hotels whose products included not only rooms but also F&B products. It should be noted that as the only products our sample data showed were rooms, F&B, meeting services, and spa services, we thus assumed that the hotels under study provided customers with only one or a combination of these four types of products and the revenue of the hotels came only from these four types of products. In reality when more operational data become available, the grouping of hotels with diverse products can be extended. As shown in Table 2, it is clear that the products offered by the hotels were diverse. Besides, during 2015-2019, on average, rooms contributed to 58%, F&B 39%, meeting services 2%, and spa services 1% of total hotel revenue. This demonstrates that room and F&B were the main sources of hotel revenue, with meeting and spa services seemingly playing a supporting role.

Table 2 Average revenue mix of hotels in GBA (2015-2019)

Group	Rooms	F&B	Meeting Services	Spa Services
G1	100%	-	-	-
G2	60%	40%	-	-
G3	55%	39%	6%	-
G4	60%	39%	-	1%
G5	56%	39%	2%	2%

Note: G1-G5 respectively represents five groups of hotels providing heterogeneous products.

To enable hotels in GBA to benchmark their performance against others and enhance resource utilization in a non-homogeneous context, we first present the five-year efficiency assessment results of the 53 sample hotels in GBA during 2015-2019. Then, combining with non-parametric analysis, we delve into their performance considering five groups of hotels and geographic locations.

4.1 Efficiency assessment of all sample hotels considering product diversification

In applying non-homogeneous DEA, determining the upper and lower limits of $\beta_{iR_q g}$ in formula (5.4) (in Appendix D) is crucial to control extreme conditions of $\beta_{iR_q g}$ (Wu et al., 2019). Following the approach used by Imanirad et al. (2013) with the collected data, we determined the upper and lower limits for each input. For total labor cost (and total operating expense), the upper and lower limits were determined by the maximum and minimum values of the proportion of the costs actually incurred in each product group (rooms, F&B, meeting services, or spa services) in each group of hotels (i.e., G2-G5). For fixed costs, the upper and lower limits were determined by the maximum and minimum values of the proportion of revenue actually generated in each product group in each group of hotels (i.e., G2-G5). Since detailed input data related to meeting services were unavailable, the determination of the upper and lower limits for the meeting services product group followed that for fixed costs. Note that the determination of upper and lower limits on the input in G1 is not necessary because there is only one product type (rooms). Appendix B provides detailed information on the upper and lower limits of $\beta_{iR_q g}$ for the input variables in 2019.

Table 3 shows the non-homogeneous efficiency results obtained through applying the non-homogeneous DEA model with the 53 sample hotels from 2015 to 2019, along with the five-year average efficiency scores, in which the rankings were based on the five-year average non-homogeneous efficiency values. Specifically, considering the hotels' diverse products, none were efficient during 2015-2019, with average efficiency values ranging between 0.044-0.376. On the one hand, this implies that the sample hotels may devise strategies to help reduce (or better utilize) their resource input without sacrificing their output to achieve efficiency at their current level of technology. One the other hand, according to models (3) and (7) (in Appendix D), the non-homogeneous efficiency score of a DMU will be optimal only when it is efficient in each of its subgroups. That is, all of the sample hotels in our study had at least one product group that was operating inefficiently. Among them, the best performing hotel was hotel HK06 in Hong Kong which offered rooms, F&B, meeting services, and spa services, with an average non-homogeneous efficiency score of 0.376 during 2015-2019, followed by Hotel GZ13 in Guangzhou, offering rooms, F&B, and meeting services, with an average non-homogeneous efficiency score of 0.353. Hotel FS04 in Foshan, providing rooms and F&B, had the worst performance, with an average efficiency score of 0.044.

Table 3 Non-homogeneous efficiency scores of hotels in GBA from 2015 to 2019

Rank	Hotel Code	2015	2016	2017	2018	2019	Average
1	HK06	0.355	0.415	0.362	0.455	0.295	0.376
2	GZ13	0.185	0.253	0.526	0.367	0.436	0.353
3	HK03	0.523	0.223	0.310	0.335	0.247	0.328
4	SZ15	0.246	0.288	0.253	0.156	0.522	0.293
5	SZ01	0.308	0.213	0.244	0.408	0.197	0.274
6	SZ02	0.355	0.135	0.235	0.261	0.348	0.267
7	GZ01	0.317	0.208	0.340	0.333	0.216	0.283
8	HK02	0.347	0.260	0.330	0.118	0.265	0.264
9	SZ06	0.337	0.272	0.352	0.242	0.234	0.287
10	SZ05	0.201	0.104	0.640	0.140	0.549	0.327
11	GZ05	0.245	0.225	0.300	0.345	0.231	0.269
12	GZ03	0.225	0.167	0.163	0.197	0.463	0.243
13	GZ10	0.240	0.293	0.200	0.185	0.228	0.229
14	SZ14	0.221	0.175	0.333	0.253	0.194	0.235
15	FS05	0.194	0.134	0.219	0.218	0.326	0.218
16	ZS02	0.251	0.125	0.289	0.226	0.181	0.215

17	FS01	0.225	0.190	0.218	0.217	0.227	0.215
18	GZ12	0.308	0.207	0.415	0.127	0.126	0.236
19	FS02	0.211	0.090	0.234	0.151	0.317	0.201
20	SZ11	0.218	0.173	0.166	0.203	0.203	0.193
21	GZ07	0.173	0.158	0.273	0.152	0.167	0.185
22	GZ08	0.220	0.115	0.178	0.182	0.204	0.180
23	SZ09	0.141	0.143	0.167	0.286	0.182	0.184
24	SZ10	0.251	0.165	0.246	0.131	0.109	0.180
25	HK08	0.207	0.147	0.208	0.163	0.151	0.175
26	GZ06	0.237	0.230	0.173	0.117	0.148	0.181
27	HZ03	0.194	0.112	0.194	0.187	0.168	0.171
28	GZ09	0.186	0.100	0.160	0.196	0.182	0.165
29	HZ01	0.194	0.098	0.196	0.183	0.187	0.172
30	SZ16	0.219	0.148	0.139	0.115	0.182	0.161
31	MC01	0.150	0.126	0.130	0.212	0.171	0.158
32	GZ14	0.133	0.124	0.229	0.156	0.159	0.160
33	HK04	0.211	0.117	0.155	0.140	0.136	0.152
34	SZ03	0.182	0.086	0.174	0.117	0.161	0.144
35	GZ02	0.175	0.215	0.267	0.082	0.096	0.167
36	ZS03	0.212	0.088	0.141	0.123	0.140	0.141
37	FS03	0.161	0.102	0.110	0.146	0.146	0.133
38	HZ02	0.146	0.071	0.154	0.140	0.133	0.129
39	GZ11	0.100	0.120	0.158	0.100	0.153	0.126
40	GZ04	0.091	0.104	0.180	0.111	0.143	0.126
41	GZ15	0.089	0.119	0.151	0.082	0.125	0.113
42	MC02	0.083	0.098	0.129	0.072	0.137	0.104
43	SZ07	0.077	0.105	0.114	0.074	0.140	0.102
44	HK01	0.081	0.093	0.120	0.061	0.146	0.100
45	SZ08	0.123	0.088	0.097	0.091	0.100	0.100
46	ZS01	0.107	0.069	0.109	0.120	0.103	0.101
47	HK07	0.042	0.107	0.161	0.036	0.104	0.090
48	SZ04	0.036	0.093	0.101	0.038	0.149	0.083
49	SZ12	0.036	0.103	0.102	0.032	0.127	0.080
50	HK09	0.023	0.085	0.118	0.033	0.114	0.075
51	HK05	0.062	0.075	0.086	0.041	0.097	0.072
52	SZ13	0.025	0.076	0.080	0.029	0.099	0.062
53	FS04	0.012	0.053	0.053	0.028	0.075	0.044
All average		0.187	0.149	0.211	0.164	0.197	0.182

Notes: FS#1-5, GZ#1-15, HK#1-9, HZ#1-3, MC#1-2, SZ#1-16, and ZS#1-3 respectively represent hotels in Foshan, Guangzhou, Hong Kong, Huizhou, Macau, Shenzhen, and Zhongshan.

Based on the entire GBA, from 2015 to 2019, the performance of hotels is far less than full efficiency (equal to one), showing that the hotels were in an inefficient state and the resource utilization and management ability of hotels rather underperformed. Although the non-homogenous efficiency scores of 30 hotels among the 53 sample hotels in 2019 were lower than those in 2015, overall, the non-homogenous efficiency scores of hotels in GBA showed a W-shaped fluctuating upward trend from 2015 to 2019.

4.2 Efficiency analysis by groups of hotels with product diversification

In the non-homogeneous DEA model, the efficiency value of a hotel depends not only on the efficiency value (e) of each product group but also on the relative importance, namely the weighting value (W), of each product group to the hotel. We used the efficiency value and the weight of each product group in each group of hotels to construct their average non-homogeneous efficiency during 2015-2019, as shown in Figure 1, where W*e represents the weighted efficiency value of each product group. For G2, G3, G4, and G5, with diverse product offerings, each type of product had an impact, which differed depending on product combinations, on the non-homogeneous efficiency score of the hotel. Specifically, the weighted efficiency of F&B surpassed that of the other product groups, indicating that F&B contributed the most to the non-homogeneous efficiency score.

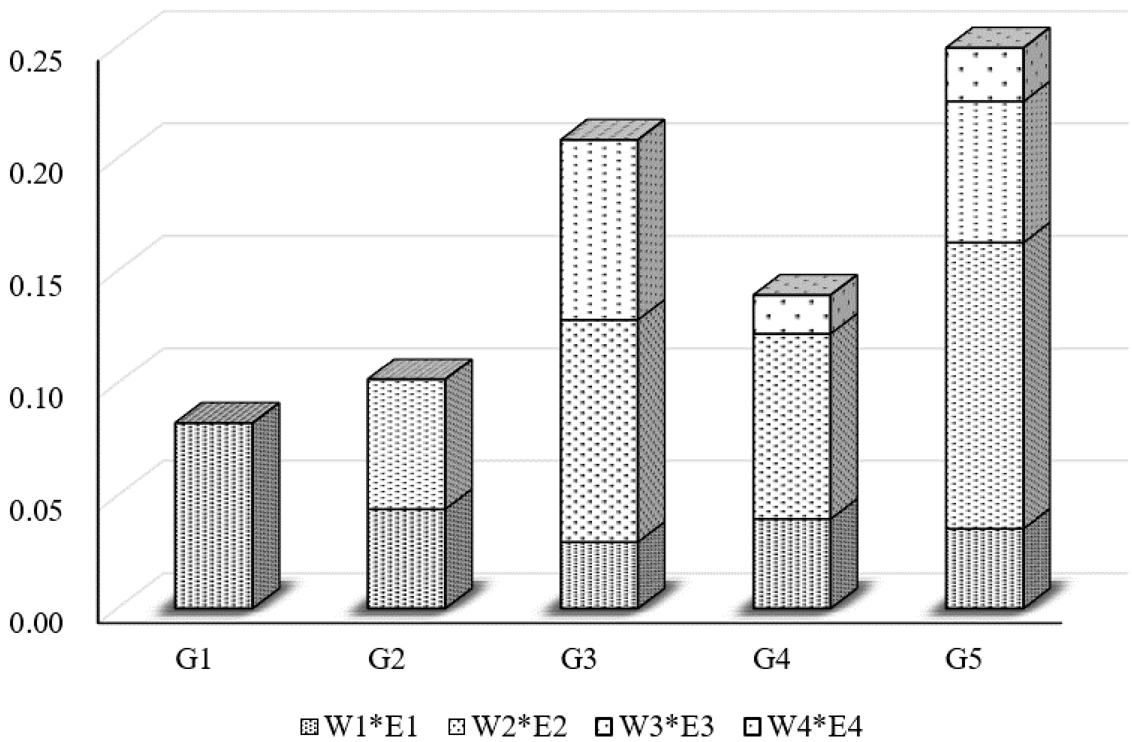

Fig. 1. Five-year average non-homogeneous efficiency scores of five product groups (2015-2019)

Note: G1-G5 respectively represent five groups of hotels providing diverse products; W#1-4 and e#1-4 represent the weights and efficiency scores, respectively, of the four product groups, namely rooms, F&B, meeting services, and spa services. W*e represents the weighted efficiency value of each product group.

The results for each product group provide useful information to better understand the non-homogeneous efficiency results. Table 4 lists the annual and five-year average efficiency values of each product group during 2015-2019. The bottom line of Table 4 shows the five-year average efficiency value of each product group and the five-year average non-homogeneous efficiency scores of the 53 sample hotels. It is observed that the average efficiency scores of rooms and F&B were 0.258 and 0.357, respectively, both lower than those of meeting services (0.566) and spa services (0.433). The sample hotels had an average non-homogeneous efficiency score of 0.182. In summary, the average non-homogeneous efficiency score of the 53 sample hotels was much lower than the full efficiency value of one, potentially attributed to the low efficiency values of rooms and F&B products. Therefore, there is room for improvement, with the average efficiency values of rooms and F&B potentially increasing by 74% and 64%, respectively. This improvement could bring these two types of products to full efficiency, consequently enhancing the non-homogeneous efficiency scores of the hotels.

Table 4 Average efficiency scores of product groups in GBA

Year	Rooms	F&B	Meeting Services	Spa Services	non-homogeneous efficiency
G1					
2015	0.032	-	-	-	0.032
2016	0.096	-	-	-	0.096
2017	0.139	-	-	-	0.139
2018	0.035	-	-	-	0.035
2019	0.109	-	-	-	0.109
Average	0.082	-	-	-	0.082
G2					
2015	0.040	0.257	-	-	0.102
2016	0.124	0.130	-	-	0.091
2017	0.132	0.177	-	-	0.120
2018	0.031	0.192	-	-	0.079
2019	0.136	0.115	-	-	0.117

Average	0.093	0.174	-	-	0.102
G3					
2015	0.121	0.275	0.624	-	0.197
2016	0.404	0.158	0.408	-	0.163
2017	0.169	0.303	0.762	-	0.249
2018	0.133	0.299	0.688	-	0.177
2019	0.224	0.410	0.635	-	0.255
Average	0.210	0.289	0.623	-	0.208
G4					
2015	0.060	0.585	-	0.080	0.146
2016	0.159	0.340	-	0.106	0.112
2017	0.163	0.586	-	0.098	0.145
2018	0.058	0.668	-	0.061	0.142
2019	0.296	0.437	-	0.085	0.151
Average	0.147	0.523	-	0.086	0.139
G5					
2015	0.489	0.595	0.451	0.745	0.272
2016	0.487	0.317	0.583	0.731	0.204
2017	0.558	0.471	0.398	0.699	0.263
2018	0.554	0.515	0.344	0.797	0.264
2019	0.578	0.404	0.616	0.425	0.244
Average	0.533	0.460	0.478	0.679	0.249
All average	0.258	0.357	0.566	0.433	0.182

Note: G1-G5 respectively represent five groups of hotels providing heterogeneous products.

Secondly, to delve deeper into the potential correlation between product diversification and hotel performance, this study employs the Kruskal-Wallis H non-parametric test (Liu et al., 2023). Detailed test results and corresponding explanations are provided in Appendix C, specifically in Tables 1 and 2. The non-parametric test results revealed significant differences between (G1, G2, G4) and (G3, G5). The efficiency values of G3 and G5 were observed to be higher than that of G1, G2, and G4. Therefore, it can be inferred that hotels with meeting services are closer to achieving optimal efficiency levels. Furthermore, it is worth noting that both G3 and G5 offer meeting services, but only G5 includes spa services. Non-parametric analysis indicates that the efficiency values of G3 and G5 are significantly different.

Additionally, it should be noted that G2 and G4 do not offer meeting services and have differences in their spa services, but these differences are not significant. Therefore, based on these two analyses, it is believed that the integration of spa and meeting services may result in improved performance levels.

To illustrate the dynamic changes in efficiency scores over time, the rightmost column of Table 4 shows the trend in the average non-homogeneous efficiency scores of different groups of hotels providing diverse products during 2015-2019. The moving trends of the average efficiency scores of G2, G3, and G4 were similar to that of the overall sample hotels, showing a sequence of decreasing, increasing, decreasing, and then increasing. Although these groups experienced fluctuation, the overall fluctuation range was relatively small, indicating relative stability in the average non-homogeneous efficiency scores of G2, G3, and G4 over time. In contrast, G1 showed an obvious fluctuation trend from 2015 to 2019, with the efficiency score changing significantly over time, signaling significant room for improvement to achieve full efficiency. On the other hand, G5's efficiency score fluctuated between 0.2 and 0.3, showing a decreasing trend followed by an increase and subsequent decrease. Hotels in G5 could focus on further reducing (or optimizing the use of) their input without compromising their outputs. Notably, only G3 and G5 hotels showed above-average efficiency values, while the rest fell below the average.

In summary, while groups providing different products exhibited varying performance levels, those with higher levels of product diversification tended to outperform others. However, the contributions of different product groups to the efficiency of hotels with varying degrees of diversification differed. The variations in efficiency among different groups may mainly stem from low efficiency values of certain products, with F&B exerting a more pronounced influence on overall hotel performance.

4.3 Hotel efficiency analysis by GBA city

In this section, considering product diversity we analyze hotel efficiency by geographic location in GBA. Table 5 depicts the five-year average efficiency values of product groups and non-homogeneous efficiency scores of hotels in each city. Although hotels in Guangzhou outperformed those in other cities in terms of the average non-homogeneous efficiency score, reaching only 0.201, it highlights an overall inefficiency trend among hotels in GBA cities. The low efficiency scores across cities can be attributed primarily to the suboptimal efficiency values of various product groups, as indicated in Table 5. It's crucial to emphasize that the efficiency score of each product group within a hotel is a relative measure compared to the best practice frontier in that specific product group. Measuring the efficiency of each product group within a hotel provides a detailed and clear understanding into the operational performance of each profit center, offering hotel managers a more objective view on departmental operating performance, beyond an omnibus performance assessment.

The average non-homogeneous efficiency score of hotels in Guangzhou, while the highest among the GBA cities, still falls short of full efficiency. Analyzing efficiency values across the four product groups of hotels in Guangzhou reveals that none of them outperforms the corresponding groups in other cities. This shows that hotels in Guangzhou could strategize to reduce their resource input in rooms, F&B, meeting and spa services by 66%, 53%, 43% and 68%, respectively, to achieve the full efficiency in each output subgroup without compromising revenue, so as to achieve full non-homogeneous efficiency. alternatively, when resource reduction is impractical, hotels are suggested to optimize resource utilization for potential output additions.

Shenzhen and Hong Kong ranked the second and third best performing cities, respectively, exhibiting relatively similar performance, likely due to their low efficiency values in rooms and F&B compared to Guangzhou. Macau, with the lowest average non-homogeneous efficiency score of 0.131, underperformed the other six cities. Despite Macau's better performance in terms of its efficiency score in F&B, its underperformance in rooms significantly impacts overall efficiency performance. Hotels in Shenzhen and Hong Kong could benchmark against those in the cities with better performance level in each product group for improvement. Hotels in Macau have significant room for improvement, with potential reduction (or, optimal usage) in resource input for rooms, F&B, meeting, and spa services by approximately 89%, 36%, 65%, and 55%, respectively.

Furthermore, to guide improvement in non-homogeneous efficiency performance, a geographic comparison of hotel performance in each product group was conducted. As shown in Table 5, Zhongshan hotels excelled in rooms, Macau in F&B, Hong Kong in meeting services, and Shenzhen in spa services, providing learning opportunities for hotels in other cities to enhance their respective product group efficiency and overall non-homogeneous efficiency performance.

To delve deeper into performance differences among hotels across cities, this study employed the Kruskal-Wallis H non-parametric test. Results, detailed in Table 3 in Appendix C, indicate significant differences in sub-services performance across GBA cities, excluding meeting services. The performance of rooms, F&B and spa show notable variations from 2015 to 2019, underscoring the distinct performance dynamics observed in the earlier analyses.

Table 5 Average efficiency scores of product groups of hotels in GBA cities (2015-2019)

City	Rooms	F&B	Meeting Services	Spa Services	Non-homogeneous efficiency
Guangzhou	0.338	0.466	0.570	0.320	0.201
Shenzhen	0.231	0.349	0.539	0.693	0.186
Hong Kong	0.216	0.351	0.705	0.433	0.181
Foshan	0.191	0.167	0.580	0.133	0.162
Huizhou	0.209	0.133	0.600	0.001	0.157
Zhongshan	0.388	0.227	0.480	0.419	0.152
Macau	0.113	0.641	0.346	0.441	0.131

In GBA, Hong Kong, Macau, Guangzhou, and Shenzhen are designated as the core engines of development, collaborating with seven key node cities (i.e., Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing) to improve the development quality of the urban agglomeration (GBA Plan, 2019). Figure 2 shows the average non-homogeneous hotel efficiency score of the core and key node cities during 2015-2019. The core cities consistently showed better performance in term of the average non-homogeneous efficiency values than the key node cities, with a fluctuating W-shaped trend of fluctuation. The efficiency values ranged between 0.16 and 0.22 for the core cities. Conversely, the key node cities experienced a 41% decrease in average efficiency in 2016 compared with 2015, but the average efficiency showed an upward trajectory in 2017-2019. Despite lower average non-homogeneous efficiency in key node cities, the overall trend indicates a progressive improvement in efficiency over time.

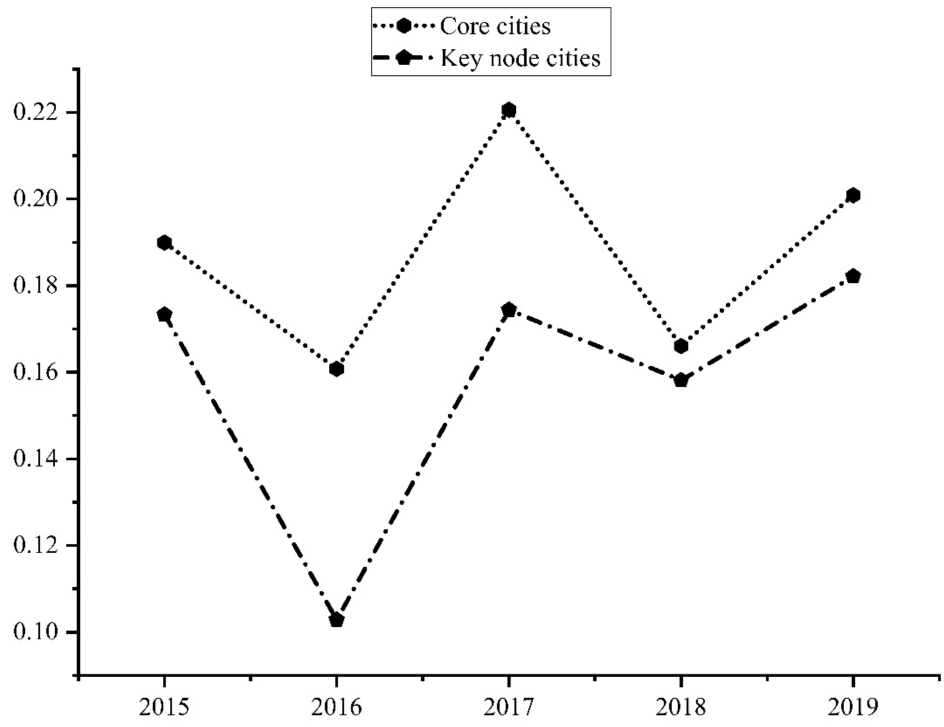

Fig. 2. Average non-homogeneous efficiency of core and key node cities in GBA (2015-2019)

5. Implications and conclusions

5.1 Theoretical implications

First and foremost, this study addresses a gap in the existing literature by conducting a micro-level analysis of hotel performance within an integrated bay area, specifically focusing on the GBA of China. While prior research has primarily centered on a country or regional scale with limited attention to the distinctive dynamics of a bay area context, this study fills this void by utilizing property-level data from 53 hotels to provide insights that hint at the broader economic significance of the hotel industry, echoing the works of de Grosbois (2012) and Jones et al. (2014).

Second, this research is one of the initial attempts to incorporate product diversification as a factor influencing hotel performance in terms of efficiency. By considering hotels offering diverse products as multi-activity entities with non-homogeneous product provision, this study goes beyond the conventional evaluation based on technology levels and hotel categorization. Our study enriches hotel performance research by offering a deeper understanding of how different degrees of product diversification may impact performance – a dimension that has received limited attention in prior studies (Arbelo-Pérez et al., 2020; Corne, 2015).

Third, this study extends the scope of traditional hotel performance assessments by including meeting and spa services, alongside rooms and F&B (Walheer & Zhang, 2018; Yu & Chen, 2016). Unlike previous studies primarily focused on overall performance, our findings uncovers how individual hotels compare across varying product provisions, shedding light on the potential contribution of each product group to overall hotel performance. This study found that hotels offering meeting and spa services were more likely to approach optimal efficiency levels, providing empirical support for a potential association between product diversity and hotel performance.

Finally, this paper advanced the application of the DEA technique with non-homogeneous DMUs, building on Cook et al.'s (2013) approach, to assess hotel performance. This departure from the conventional homogeneity assumption recognizes the unique output bundle of each hotel, addressing a notable deficiency in traditional DEA efficiency measurment. Consequently, the efficiency evaluation results obtained are likely more realistic, enhancing the ability to distinquish better-performing hotels on a fairer basis. Although similar methods have been used to estimate the efficiency of China's industrial sector by Wu et al. (2019), their approach faced challenges related to arbitrary determinations of upper and lower limits of each input allocation ratio, lacking practical significance (Li et al., 2016). In contrast, our study considers the diversity of hotels' output indicators and introduces an empirical data-driven method to determine the upper and lower limits of each input allocation ratio, steering away from subjective assignment as seen in previous studies. This refinement enhances the practicality and the model's ability to accommodate a more diverse range of output indicators, improving the fairness in differentiating between better-performing hotels.

5.2 Managerial implications

The findings of this study could guide hotel decision-makers and managers to improve hotel performance in terms of efficiency. First, hotels can take advantage of our proposed method introduced in this study, incorporating product diversification in performance evaluation. This approach provides a more objective assessment of a hotel's performance, revealing aspects that traditional KPIs or conventional DEA tools may overlook. Our results show that efficiency scores, considering the non-homogeneity of hotels, tend to be lower than those derived from the traditional CCR-DEA model. This implies that relying solely on the traditional model may lead to a falsely positive perception of performance, emphasizing the benefit of adopting our proposed model for a more realistic assessment.

On a micro level, our study delves into the performance of hotel groups offering diverse products, unraveling the unique contributions of rooms, F&B, meeting services, and spa services to the non-homogeneous hotel performance assessment across the seven GBA cities. These detailed results allow hoteliers in GBA cities to make more informed decisions, strategic investment, and operational adjustments. Hotel managers can benchmark their hotel's performance against others in GBA, identifying product groups crucial to hotel operations yet displaying suboptimal performance levels. With an understanding of the weight and efficiency values of each product group, managers can implement measures such as optimizing resource input to improve overall hotel performance.

Hotels can leverage existing resources by considering product diversification, consistent with Yang et al.'s (2017) argument for a diversified customer base (Rahimi & Kozak, 2017). Given the inherent diversity among customers (Tsai et al., 2017), providing diversified services can help hotels attract a broader clientele and enhance their efficiency performance. Thus, hotels can maximize their existing resources by considering diversified product mixes and providing ancillary services, such as spa, meeting, or special F&B offerings. This strategic approach not only extends the stay time of customers but also establishes diversified revenue sources (Kim et al., 2022), contributing to non-homogeneous hotel performance.

Last, hotels in key node cities are advised to benchmark their performance against those in core cities, identifying underperforming products to enhance non-homogeneous hotel performance. In addition, governments of key node cities can consider offering tax incentives to encourage hotels adoption of new technologies, fostering collaboration with core cities to jointly promote the development of the hotel industry. Despite hotels in Guangzhou outperforming those in other GBA cities, the overall efficiency performance remains suboptimal. This underscores the importance for hotel managers to concentrate on improving the efficiency of each department to maintain a competitive advantage. In particular, Macau hotels could prioritize enhancing the operational and management efficiency of rooms and meeting services while maintaining strong performance in F&B and spa services to enhance their non-homogeneous efficiency. Finally, the study reveals variations in efficiency performance among hotels across GBA cities, offering a strategic recommendation for hotels in GBA to benchmark their performance against those in specific cities: Zhongshan for rooms, Macau for F&B, Hong Kong for meeting services, and Shenzhen for spa services.

5.3 Conclusions

In measuring hotel performance in terms of efficiency in a more practical manner, this study took into account the diversity of products provided by the sample hotels in seven cities in GBA during 2015-2019 by employing the DEA technique with non-homogeneous DMUs. The results show that, first, considering product diversification, the non-homogeneous efficiency scores of the 53 sample hotels in GBA ranged from 0.044-0.376. This indicates that the hotels in GBA were not efficient, with at least one type of their products causing this inefficiency. Second, there were significant differences in the non-homogeneous hotel efficiency considering their diverse product provisions. While F&B alone had a greater impact on the overall hotel performance, this study finds that hotels with higher product diversity are generally closer to achieving optimal efficiency levels. Specifically, hotels that provide rooms, F&B, meeting and spa services exhibit superior performance. The second-ranking hotels excel in providing rooms, F&B, and meeting services. However, it is noteworthy that hotels offering rooms, F&B, and spa services do not outperform those offering only room and F&B services or solely room services in terms of efficiency. Third, considering heterogeneity, among the seven GBA cities, the non-homogeneous efficiency scores of the hotels in the core cities was better than that of those in key node cities.

6. Limitations and Future Research

This study is not without limitations. First, our research findings and key conclusions were derived from data from 53 hotels in GBA during 2015-2019, sourced from STR Global. Second, our study exclusively focused on product diversification within hotels, such as rooms, F&B, meeting services, and spa services. In reality, hotels may also offer other products; however, the scope of product diversity in this study was confined to the financial data reported to STR Global by individual hotels. Third, this study only considered the internal heterogeneity of a hotel; the external environmental factors affecting efficiency was not considered in this study. Readers should bear these limitations in mind when interpreting the benchmark narrative.

Therefore, future studies can, first, validate the results of this study by using data from a larger sample of hotels. Second, the diversity of more products provided by hotels, such as golfing and online retail, could be studied so as to assess the non-homogeneous efficiency of hotels more comprehensively. Third, the evaluation of hotel efficiency considering both internal and external heterogeneity as well as the factors that may impact the lower or higher hotel efficiency values could also be a future research direction.

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