Preparing for a future crisis: using DEA-based performance analysis to assess initial pandemic responses in the Taiwanese hotel industry

Received 11 January 2023
Revised 28 February 2023
Accepted 18 April 2023

Yu-Hsiang (John) Huang
Georgia College & State University, Milledgeville, Georgia, USA, and
Bradley Meyer, Daniel Connolly and Troy Strader
Drake University, Des Moines, Iowa, USA

Abstract

Purpose – Taiwan's hotel industry was adversely impacted by the COVID-19 pandemic. This study aims to examine the effect of strategic choices by Taiwanese international tourist hotels before and during the pandemic environments.

Design/methodology/approach – A data envelopment analysis (DEA)-based Malmquist methodology is used in this study to provide a mechanism to assess Taiwanese hotel strategy performance. Changes in the productivity and performance of Taiwanese international tourist hotels were analyzed in the periods before and during the pandemic to uncover insights useful should a similar crisis occur in the future. Panel data were obtained from the annual report of international tourist hotels published by the Taiwan Tourism Bureau from 2017–2020. Two groups of hotels were analyzed in this study: city hotels and scenic hotels.

Findings – The findings of this study reveal that chain hotels tended to perform better than independent hotels in both city and scenic areas during the global pandemic. Specifically, the crisis caused a substantial decline in productivity and profitability for international tourist hotels in Taipei City during the COVID-19 period. Compared to city hotels, findings also indicate that most international tourist hotels in scenic areas were able to maintain better productivity, including larger-sized scenic hotels.

Originality/value – The DEA-based analysis provides unique and valuable insights for hotel firm leaders on how to better identify and make strategic choices when responding to future crises.

Keywords Pandemic, Taiwanese hotel industry, Taiwanese international tourist hotels, Data envelopment analysis, Malmquist productivity index, Productivity, Strategic choices

Paper type Research paper

Introduction

Since the start of the pandemic in 2020, a number of hospitality and tourism-related research studies have emerged to investigate a myriad of important topics. Studies have investigated the economic impact of COVID-19 on the hotel industry, hotels' responses to the pandemic, resiliency, efficiency, productivity and most recently, recovery. Other studies have analyzed strategies and performance impacts for restaurants, bars and beverage producers (Norris, Taylor, & Taylor, 2021), national parks (Templeton, Goonan, & Fyall, 2021) and gambling-related businesses (Ghaharian, Abarbanel, Soligo, & Bernhard, 2021). Clearly, the COVID-19

International Hospitality Review
Emerald Publishing Limited
2516-8142
DOI 10.1108/IHR-01-2023-0003

crisis has severely impacted the global hospitality industry and significantly altered how hospitality and tourism businesses will operate going forward. Various government policies and travel restrictions resulted in temporary or permanent closure of many hotels, restaurants and other hospitality and tourism-related businesses worldwide (Gursoy & Chi, 2020; Tsai, 2021). The USA Today, for example, reported that the initial impact of the pandemic resulted in nearly 80% of US hotel room inventory going vacant and hotel occupancy rates that dipped into single digits (Oliver, 2020). Similar sharp declines were reported in Europe, Asia and elsewhere (Nicola *et al.*, 2020). Taiwan was no exception.

Taiwan is an island in the center of East Asia surrounded by the Pacific Ocean. Along with a beautiful natural landscape, hot springs, pleasant food and numerous cultural characteristics, Taiwan provides attractive tourism conditions for visitors around the world with over 100 mountains scattered throughout the island (Tsai, 2021). As the pandemic lingered, both supply and demand in Taiwan's hotel industry fell abruptly (Fu, 2020), especially the international tourist hotels that play a critical role in the overall performance of the Taiwanese hotel industry. Fu (2020) provides a detailed account of how the COVID-19 pandemic devastated the Taiwanese hotel industry, a key contributor to Taiwan's economic vitality. Both supply and demand were essentially shattered. There was a direct inverse correlation between the rise in reported COVID-19 cases and the deterioration of key hotel performance metrics. Closed borders and the suspension of tourist visas virtually eliminated the hotel industry's primary source of revenue, the international traveler. Moreover, domestic travelers, fearful of being stricken by COVID-19 and subject to lockdown, were either reluctant or unable to travel. The loss of demand had devastating effects resulting in many of the island's top hotels either closing or significantly reducing room capacity by closing floors or entire wings. Consequently, all key performance measures (such as occupancy rates, average daily rates, revenue per available room, profits, etc.) saw precipitous declines, as did the number of employees. Fortunately, the rapid response and proactive safety measures instituted by the Taiwanese government brought the pandemic quickly under control. These actions, along with relief packages and revitalization efforts (new marketing campaigns and incentive packages) provided to the industry, brought relief and signs of recovery to the hotel industry (Fu, 2020).

How the pandemic affects individual hotel performance and productivity depends on a number of factors such as location, hotel type, segments served, hotel size, timing, ownership structure, brand affiliation, hotel strategy, management interaction and technology capabilities, among others (Kim, Kang, Chung, & Choi, 2021). These issues affect hotels in all areas of the world, but the impact varies due to differences in each hotel's strategic environment. This study explores changes in hotel productivity and performance in Taiwan's international tourist hotels (including those also popular with domestic tourists) before and during the pandemic.

Taiwan has often been commended for its response to the COVID-19 pandemic because government leaders took swift action to implement defensive measures just weeks after the first case of COVID-19 was reported in Wuhan, China (Tsai, 2021; Fu, 2020). These actions included the creation of the Central Epidemic Command Centre (CECC), broad distribution of medical-grade masks, implementation of border controls, mandatory social distancing, restrictions on the size of public gatherings and adoption of strict hygiene and sanitation protocols (Fu, 2020). As a result of swift action and strict measures, Taiwan's hotel industry rebounded faster than what the industry has reported in other parts of the world and is often held up as a model for hotels elsewhere seeking to recover from the pandemic.

Prior to the pandemic, international travelers traveling for leisure accounted for the lion's share of Taiwan's hotel guests, with the Asia-Pacific region contributing nearly 10.6 million (or 89%) of its 11.9 million annual visitors in 2019 (Tsai, 2021). International travelers are attracted to Taiwan because of its natural beauty, diverse culture, advanced technology,

friendly people and wonderful cuisine (Hsieh & Lin, 2010). Following the pandemic there was a noticeable trend in the increase of domestic tourism, which has been attributed to concerted efforts made by the Taiwanese government to promote domestic tourism while also continuing to market Taiwan as a destination island to international travelers.

According to Im, Kim, and Miao (2021), an increasing number of hotel companies adopted diverse strategies, reallocated resources and made changes in operations at an unprecedented pace in response to the developing crisis of COVID-19. These pivots led to the following research questions addressed by this study:

RQ1. What were the effects of COVID-19 crisis response strategies on Taiwan's international hotel performance? And

RQ2. how can an international tourist hotel in Taiwan leverage or adapt its strategic choices to better allocate resources in response to a pandemic-induced hotel crisis?

To address these questions, this study systematically reviewed statistics from 60 international hotels located in Taiwan during the years 2017 to 2020 and evaluated the performance of the hotels using Malmquist productivity measures. Insights were then drawn from the analysis to assist executives of international tourist hotels in responding to challenges posed by future crises or pandemics. The following section reviews the relevant literature to build a proper foundation for this study. The third section presents this study's methodology and the next section describes the quantitative model and discusses the empirical data analysis results for Taiwan's international tourist hotels included in this study. The concluding section discusses the study's findings, implications and directions for future research.

Literature review

Luxury and high-end hotels and resorts are complex and capital-intensive businesses that often include lodging, restaurants, retail, spas, recreational facilities and more, all under one roof. Each of these service businesses operates in dynamic and competitive environments where their success is determined by a variety of factors and a host of variables that must be carefully managed. Business volume can be seasonal and is highly correlated with economic cycles. Guests are heterogenous, meaning their expectations vary, and labor can be inconsistent and unpredictable at times. To explain how organizations evolve, Abatecola, Belussi, Breslin, and Filatotchev (2016) apply a biological metaphor. Like biological organisms, businesses operate in an ecosystem and must adapt to their environments or risk becoming obsolete. This requires environmental scanning, forecasting trends, identifying the drivers of change and predicting their timing and impacts. According to Hamel and Prahalad (1994b), many business failures are a direct result of an organization's inability to anticipate or foresee the future and adapt accordingly.

Environmental scanning

The hotel industry is no stranger to disruptions due to environmental forces and economic downturns (Jiang & Wen, 2020). It has faced a number of crises in its history resulting from events such as terrorism, health outbreaks, natural disasters and economic recessions. Consider for example, the attacks of September 11, 2001, the 2002-2004 severe acute respiratory syndrome (SARS) outbreak and the economic recession of 2008. These events imposed significant challenges that adversely impacted profitability, but their impacts pale in comparison to that of the COVID-19 pandemic. While prior crises taught industry leaders important lessons, they did not adequately prepare them for the level of disruption caused by COVID-19. Earlier crises were shorter in duration with less government intervention, fewer travel restrictions and less impact to the labor supply. Because they did not rise to the level of a worldwide pandemic, actions taken to address the threats were less universal or more

localized. Their global impact was less severe, but felt nonetheless. Impact was more acute in the regions directly impacted. In each of these cases, the hotel industry demonstrated resiliency, adapted and bounced back.

Normative theory in strategy development suggests that strategy should dictate structure (Venkatraman, Henderson, & Oldach, 1993; Amitabh & Gupta, 2010). In practice, however, having strategy drive organizational structure versus allowing structure to define (or constrain strategy) is difficult to achieve (Hofer & Schendel, 1978) and somewhat contrary to popular opinion (Amitabh & Gupta, 2010). Organizational culture, leadership, size, hierarchy, policies, procedures, resources, budget and maturity (i.e. lifecycle stages) are all tied to an organization's structure. As a result, they can either favorably or unfavorably impact the strategies chosen or not chosen by a firm. Therefore, it is not uncommon, especially within the hotel industry, for firms to base their strategies on the constraints and limitations of existing structure and/or available resources and capabilities (Olsen, Murthy, & Teare, 1994; DeMicco, Davies, & Cetron, 2019). While understandable because of its pragmatic nature, this approach can limit a firm's vision and, therefore, its potential and relevancy.

Because most businesses today operate in dynamic, tumultuous, ever-changing and highly competitive environments, executives must lead and make decisions in times of uncertainty. Environmental scanning is a useful tool to help executives reduce uncertainty and risk by systematically assessing the macro environment (i.e. political, economic, social-cultural, technological, legal/regulatory and environmental factors) and task environment (competitive landscape, suppliers, customers and labor market) to identify trends, catalysts of change, threats and opportunities; paint a picture of the future; and assess probable timing and potential impacts (Albright, 2004; Babatunde & Adebisi, 2012; Amuna *et al.*, 2017). The co-alignment principle describes causal linkages between how a firm responds to environmental events and its performance. More specifically, the co-alignment theory posits that to achieve success, a firm must be able to (1) successfully identify environmental events that will impact the firm, (2) develop appropriate strategies, products, services and competitive methods to capitalize on opportunities and negate or mitigate potential threats and (3) consistently allocate resources (i.e. people, capital and technology) to support the firm's chosen strategies and competitive methods. If these are done appropriately, and the firm is properly aligned with its internal and external environment, the firm should outperform other industry players and achieve success as measured by various performance metrics, such as profitability, market share and cash flow per share (Venkatraman & Prescott, 1990; Venkatraman *et al.*, 1993; Olsen *et al.*, 1998; DeMicco *et al.*, 2019).

Scanning the external environment and incorporating the findings into the strategic planning process involves three critical management activities: analysis, decision and action (Babatunde & Adebisi, 2012; Kazmi, 2008; Dess, 2005). Applying the logic of the co-alignment principle, the hotel industry theoretically should have been able to identify the risk of a significant pandemic event. However, the industry was caught relatively flatfooted, hit very hard and forced to react. Demand practically dried up, and government regulations greatly impacted operating capacity. Hotel revenues and occupancy rates plummeted forcing hotel operators to respond quickly and with drastic measures, including employee layoffs, reduced services and amenities, interrupted cash flows, and, in some cases, closures (Filimonau, Derqui, & Matute, 2020; Hall, Scott, & Gössling, 2020). Industry leaders responded by focusing primarily on health, safety and survivability of their businesses. They implemented new sanitation standards, protocols and procedures. These sanitation standards and protocols were mandated by the Taiwanese government and local health departments (Taiwan Centers for Disease Control, 2020). They reduced room inventory capacity, eliminated daily housekeeping service in guestrooms, modified service delivery practices and adopted more technology solutions to offer contactless service and self-service options. To be fair, many technology developments were already in the works. The pandemic just

accelerated their adoption. Had industry leaders conducted more thorough environmental scanning efforts, created what-if scenarios and developed appropriate contingency plans, they may have been in a position to take proactive measures and, in doing so, soften the financial fallout their businesses experienced as a result of the pandemic.

As the number of COVID-19 cases declined and as more people got vaccinated, the hotel industry started to see signs of recovery. Industry leaders turned their attention to returning to normal; that is, re-opening rooms taken out of inventory during the height of the pandemic, restoring services and striving to achieve 2019 (i.e. pre-Covid-19) performance levels (i.e. occupancy rates, average daily rates, revenue per available room and profits). Today, industry leaders are beginning to look beyond the pandemic to an industry that will be forever changed. Their focus now is on transformation, which is necessary not only to pandemic-proof hotels but also to address other pressing and convergent issues. These include a major labor shortage at a time when hotel demand is rapidly increasing, inflation, the threat of an economic recession, supply chain issues, instability in various parts of the world and a new wave of technology advancement brought on by the Fourth Industrial Revolution that is beginning to take shape (Haag, 2022). Hamel and Prahalad (1994a) suggest that in volatile times, managers must think differently and be visionary. Success in a post-pandemic world will require hotel leaders to reimagine and innovate (Sigala, 2020).

Scanning the environment, identifying early indicators of a major event, assessing the probability of its occurrence and accurately predicting its timing and impact can be difficult, as the pandemic proved. It is unfair to single out hotel leaders and criticize them for not proactively anticipating the impact of a growing pandemic on their own operations because they were not alone. Many government officials and business leaders in other industries were equally caught off guard. They were ill-prepared and had to scramble to pivot. Because the COVID-19 pandemic has little resemblance to past crises, and because the virus continued to morph, leaders were unable to accurately predict its behavior and impacts, making it difficult to design appropriate and effective defensive measures (Sigala, 2020). Despite these difficulties, the pandemic revealed the gross inadequacies, the lack of discipline and the absence of formal environmental scanning processes companies have in place (Wambua & Omondi, 2016; Babatunde & Adebisi, 2012; Benczúr, 2005; Albright, 2004; Olsen *et al.*, 1994).

As Amuna *et al.* (2017, p. 28) so aptly stated, managing crisis in an ever-changing and turbulent environment is challenging and if not managed well, the outcomes can result is disastrous. In hindsight, hotel leaders wish they had been better prepared for the pandemic. They should have realized the importance of staying abreast of environmental events, the need for contingency planning and effective resource allocations when encountering future business disruptions (Filimonau *et al.*, 2020; Fu, 2020; Alonso *et al.*, 2020). To avoid being caught by surprise and having to operate in a reactive mode, Yamamoto and Sekeroglu (2011) and Panos (2013) advocate for using environmental scanning to conduct a systematic approach to proactively identifying potential crises and then planning appropriate responses long before any crisis should arise. Yarmohammadian, Alavi, Ahmadi, Fatemi, and Moghadasi (2016) suggest that this systematic approach should include three stages: (1) a pre-crisis stage to focus on prevention and preparation, (2) a response stage which deals with how to address the crisis at hand and (3) a post-crisis stage in which a postmortem is conducted to identify key learnings and improve preparedness for and responses to future crises.

Resources and capabilities lead to resiliency and competitive advantage

A firm's resources and capabilities are often cited as key contributors to competitive advantage. The premise behind the resource-based view (RBV) of the firm is that a firm's performance is a function of its resources and capabilities and how they are deployed (Kraaijenbrink, Spender, & Groen, 2010; Armstrong & Shimizu, 2007; Barney, 2001;

Mata, Fuerst, & Barney, 1995). Using this framework, a company can create competitive advantage through the culmination and convergence of a series of events, resources, experiences, intellectual capital, organizational competencies and underlying management processes. In other words, a firm achieves competitive advantage not only from the competitive methods it chooses, but also from the assets it has at its disposal (Kraaijenbrink *et al.*, 2010; Armstrong & Shimizu, 2007; Barney, 2001; Mata *et al.*, 1995). Competitive advantage is the result of a series of ingredients or idiosyncratic resources (rather than from a single factor) that when combined and used in tandem, generate advantages in the marketplace that are difficult for competitors to duplicate. According to Slywotzky (1996, p. 4), value stems from a company's business design: "the entire system for delivering utility to customers and earning a profit from that activity."

It is a firm's resources and capabilities that make it possible for that firm to execute its strategies and realize benefits. Resources include people, capital, technology, facilities, etc. They are combined and often augmented via strategic alliances to create the firm's core competencies, competitive methods and portfolio of products and services. The skills, capabilities, expertise and reputation (i.e. credibility) along with the individual and collective experiences of a firm's workforce can impact the strategies undertaken and the corresponding resource allocations—even though cognitive strategic theory (that is, the co-alignment principle described earlier) suggests that strategy should be defined based on environmental opportunities and threats without regard to a firm's existing resources and capabilities. Catastrophe preparedness, the ability to cope/pivot and resiliency are functions of a firm's resources and capabilities (Herbane, 2019; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2018). These, along with strong change management processes (Ates & Bititci, 2011) and a learning culture (Kanter, 2020; Pal, Torstensson, & Mattila, 2014), aid in determining a firm's resiliency (Alonso *et al.*, 2020). Hallak, Assaker, O'Connor, and Lee (2018) posits that self-efficacy and innovation are also characteristics of businesses demonstrating strong resiliency.

How hotel leaders address a crisis is dependent on their assessment of the potential impact, availability of resources, their effective allocation of those resources and the agile nature of their organizations (Brown, Rovins, Feldmann-Jensen, Orchiston, & Johnston, 2019). For major business disruptions such as those caused by the COVID-19 pandemic, it takes vast amounts of capital (human, monetary, technology, etc.) to plan, prepare, adapt and recover (Jiang, Ritchie, & Verreynne, 2019). Hotels that are well resourced tend to demonstrate stronger resiliency when faced with adversity and business disruption; as such, they will likely fair better and have a greater chance of long-term viability coming out of the pandemic than hotels having fewer resources (Filimonau *et al.*, 2020).

Productivity, data envelopment analysis (DEA) and Malmquist productivity index (MPI)

Research by Neves and Lourenço (2009) reinforces the notion that performance measurement is an essential consideration for hotel executives when defining strategic priorities and allocating resources. A summary measure of the performance of hotels is productivity; that is, a ratio of output to input. Thinking more broadly than the hotel industry, early measures of productivity focused on output per labor hour, which is an example of single factor productivity (the single factor being labor hours). The continued effect of the Industrial Revolution made the capital portion of production input more and more significant; as such, it became useful to formulate productivity as a ratio of output to the sum of capital and labor input (a multifactor productivity ratio). When other resource inputs are used, such as energy or materials, a commonly used term is total factor productivity (TFP), where the top of the ratio is some measure of output in economic value (such as dollars) and the bottom of the fraction is the sum of the cost of all inputs.

The challenge with computing TFP is the pricing question. Prices of labor vary from one market to another and the prices of outputs depend on supply and demand traits of the market in which they are sold. Similar concerns can be raised about the pricing of utilities used and the pricing of materials thus making the reporting of productivity statistics suspect due to having to depend on too many price assumptions. The response to this concern has been two-fold. One is to measure productivity change rather than raw productivity, but more importantly, the other is to measure productivity with a methodology that does not require prices, but instead, works directly with non-priced input units. Malmquist suggested such a method in 1950s, but this method was not implemented generally until after Charnes, Cooper, and Rhodes (1978) developed data envelopment analysis (DEA).

DEA is a methodology built on linear programming that compares the performance of a set of decision-making units (DMUs), and a series of inputs (e.g. cost) and outputs (e.g. return) are identified with known values for each DMU. The methodology then assesses the ability of each DMU to use its inputs to generate its outputs (Banker, Chang, & Pizzini, 2004, 2011; Schrage, 1997; Tone, 2001). Compared to conventional performance evaluation approaches, DEA lessens the complexity of analysis by concurrently measuring the relevant attributes of multiple DMUs and then turning out a composite score. The key feature of the DEA model is to uncover hidden relationships between numerous inputs and outputs (Huang, Tu, Strader, Shaw, & Subramanyam, 2019). To put it simply, there is no need for a DEA model to include explicit mathematical forms between inputs and outputs, and this indicates that the DEA model allows greater flexibility when selecting the inputs and outputs (Huang *et al.*, 2019). By considering each DMU, the method implicitly develops a frontier of best performance and compares every DMU to that frontier by computing an efficiency measure between 0 and 1 for each DMU. In this way, DEA can be used for benchmarking by helping a hotel company identify its best performing DMU (Hu, Shieh, Huang, & Chiu, 2009; Chin, Wu, & Hsieh, 2013; Wu, Lan, & Lee, 2013). Among various types of DEA models, the DEA-based Malmquist index is a popular method to measure efficiency changes of a DMU between different time periods in the hotel industry (Wu *et al.*, 2013).

Malmquist Productivity Index (MPI) was proposed by Caves, Christensen, and Diewert (1982) and Fare, Grosskopf, and Lovell (1994) built on this concept and employed panel data to determine productivity change for each DMU from one time period to another. Goncharuk (2019), for example, used an MPI approach in the winemaking industry, whereas Isik and Hassan (2002) applied MPI to the banking industry. Several studies have applied MPI specifically in the hotel industry. Hwang and Chang (2003) found that differences in efficiency change were due to differences in the source of customers and in management styles. They partitioned the 45 hotels studied into six clusters with specific recommended strategies for each cluster. Barros and Alves (2004) studied 42 hotels in Portugal's public hotel chain, Enatur. MPI identified benchmark hotels the other hotels could learn from and noted that the chain was suffering from a lack of technological innovation. The impact of external environment factors was explored by Wang, Hung, and Shang (2006). They used MPI to demonstrate that managerial style had insignificant impact on pure managerial efficiency once effects of external environment were removed. Neves and Lourenço (2009) concluded that hotel managers in their worldwide sample of 83 hotel companies should concentrate on productivity improvements and not on scale issues. Pulina, Detotto, and Paba (2010) found that on the island of Sardinia, the hotel industry was declining. Medium sized hotels were relatively the most efficient, but all hotels suffered from excess labor and capital cost associated with highly season demand. Legislative interventions, transportation infrastructure deregulation, location, tourism demand and life cycle were also seen as having important impacts. Huang, Mesak, Hsu, and Qu (2012) supplement the MPI methodology with a Tobit model to examine the impact of macro contextual factors on hotel efficiency. They examine the Chinese hotel industry as it experienced and recovered from the SARS epidemic.

Methodology

The sections that follow describe the study's DEA model and explain the decomposition of MPI values.

Data envelopment analysis (DEA) model

DEA is non-parametric and does not require any particular characteristics to convert inputs to outputs (Ragsdale, 2018). The conventional DEA model developed by Charnes *et al.* (1978) assumes that the DMUs are operating under constant returns to scale (CRS). Banker, Charnes, and Cooper (1984) extended the model to allow variable returns to scale (VRS). With reference to Cooper *et al.* (2011), Huang *et al.* (2012) and Chin *et al.* (2013), the DEA model is described below.

$$\text{Max } z = \sum_{r=1}^{s} u_r y_{ro} - u_o$$

subject to

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - u_o \leq 0, \quad j = 1, \ldots, n$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1$$

$$v_i \geq \varepsilon, \; u_r \geq \varepsilon, \; u_o \text{ free in sign}$$

This linear program is run separately for each DMU; that is, for each hotel included in this study. The variable z is the derived efficiency of the DMU, and the maximum possible value for z is 1 (or 100%) efficiency. There are n DMUs in the set under analysis. Moreover, u_r and v_i represent the weight of the r th output and the i th input respectively; m is the number of inputs; s is the number of outputs and $\varepsilon > 0$ is a non-Archimedean element defined to be smaller than any positive real number. Additionally, y_{ro} represents the amount of output r produced by DMU_0, while x_{io} represents the amount of input i used by DMU_0. A set of constraints (one for each DMU) reflects the condition that the weighted sum of the outputs cannot be greater than the weighted sum of the inputs (i.e. no DMU can have an efficiency greater the 100%). The other constraint forces the weighted sum of the inputs for the given DMU to be equal to 1. If u_0 is zero, the DEA-based model is restricted to CRS, otherwise, the DEA-based model allows VRS.

Malmquist productivity index (MPI) and DEA model

MPI uses input and output time series data to assess the direction of productivity changes across multiple time periods. According to Cooper *et al.* (2011), productivity trends provide useful insight for managers. MPI introduced by Caves *et al.* (1982) based on the quantity index developed by Malmquist (1953) calculates the ratio of distance functions corresponding to input and output vectors in periods t and $t + 1$.

$$\frac{y^{t+1}/x^{t+1}}{y^t/x^t} = \frac{(y^{t+1}/x^{t+1})D_0(1,1)}{y^t/x^t D_0(1,1)} = \frac{D_0(x^{t+1}, y^{t+1})}{D_0(x^t, y^t)}$$

The distance function, $D_0(x^t, y^t)$, represents the ratio of the output vector y at time t to the maximum possible output vector y, given the input vector x at time t using the current

production technology (i.e. production function). The distance function computation requires a reference point, and to avoid an arbitrary choice of time t or time t+1. In this regard, Fare *et al.* (1994) derive MPI as the geometric average of the ratios at both of these reference times as shown below. M is short for MPI, and the subscript o specifies that this is an output index. Following Fare *et al.* (1994) and Mohammadi and Ranaei's (2011) work, Mo > 1 indicates improvements in productivity; Mo < 1 indicates productivity loss or deterioration in performance; Mo = 1 means no change in productivity from time t to $t + 1$.

$$\text{Mo} = \left[\frac{D_0^t(X_0^{t+1}, Y_0^{t+1})}{D_0^t(X_0^t, Y_0^t)} \times \frac{D_0^{t+1}(X_0^{t+1}, Y_0^{t+1})}{D_0^{t+1}(X_0^t, Y_0^t)}\right]^{1/2}$$

This formula can be rewritten as shown below and decomposed into two components: an efficiency change component (EFFCH) and a technical change component (TECH) of productivity change (Fare, Grosskopf, & Margaritis, 2011; Mohammadi & Ranaei, 2011; Kim *et al.*, 2021).

$$\text{Mo} = \frac{D_0^{t+1}(X_0^{t+1}, Y_0^{t+1})}{D_0^t(X_0^t, Y_0^t)} \times \left[\frac{D_0^t(X_0^{t+1}, Y_0^{t+1})}{D_0^{t+1}(X_0^{t+1}, Y_0^{t+1})} \times \frac{D_0^t(X_0^t, Y_0^t)}{D_0{}^{t+1}(X_0^t, Y_0^t)}\right]^{1/2}$$

$$\text{EFFCH} = \frac{D_0^{t+1}(X_0^{t+1}, Y_0^{t+1})}{D_0^t(X_0^t, Y_0^t)}$$

$$\text{TECH} = \left[\frac{D_0^t(X_0^{t+1}, Y_0^{t+1})}{D_0^{t+1}(X_0^{t+1}, Y_0^{t+1})} \times \frac{D_0^t(X_0^t, Y_0^t)}{D_0^{t+1}(X_0^t, Y_0^t)}\right]^{1/2}$$

Malmquist productivity index (MPI) = an efficiency change component (EFFCH) * a technical change component (TECH)

According to Fare *et al.* (1994, 2011) and Tone (2004), an EFFCH measures the relative deviation from the production frontier, which indicates how efficiently a DMU transforms inputs into outputs from maximum potential production between period t and period $t + 1$. A hotel may facilitate its improvement in EFFCH when allocating the inputs more efficiently under the existing technology (Kim *et al.*, 2021). Furthermore, a TECH measures the production frontier shift between period t and period $t + 1$. A frontier can shift by influencing various factors and taking various actions such as the adoption of new technology or policy changes if they improve operations and lead to higher potentials of productivity (Kim *et al.*, 2021).

Empirical study

The COVID-19 pandemic required hotel managers to make difficult strategic choices in the face of significant environmental disruption. A DEA-based Malmquist methodology provides a mechanism to assess the performance of these strategies. This study analyzed changes in the productivity and performance of Taiwanese international tourist hotels in the periods before and during the pandemic to uncover insights useful should a similar crisis occur in the future.

Data from Taiwan's international tourist hotels in Taipei City and scenic areas (2017 to 2020)

The panel data in this study were obtained from the annual report of international tourist hotels published by the Taiwan Tourism Bureau during 2017–2020. With respect to sample selection,

two groups of hotels were analyzed in this study: city hotels and scenic hotels. City hotels included in this study are located in Taipei, an international city with a population of about 2.3 million. The scenic hotels are located near the ocean or in mountainous areas on the island. Productivity and performance data from 60 hotels (43 from Taipei and 17 located in scenic destinations) were analyzed. The sample set included 34 chain (or major branded) hotels and 26 independent properties. Table 1 provides more detail on the subdivision of hotels.

As noted previously, the restrictions on international travel to Taiwan had a dramatic effect on hotel demand. International visitors to Taiwan in 2017, 2018, 2019 and 2020 were, respectively (in millions), 10.7, 11.1, 11.9 and 1.4. Domestic outbound travel also decreased dramatically in 2020. Outbound traffic during the years 2017 to 2020, respectively, were (in millions) 15.6, 16.6, 17.1 and 2.3. Figure 1 shows that in non-pandemic years, the city hotels were dominated by international visitors and scenic hotels were dominated by domestic travelers. When the borders were shut down, the city hotels lost most of their international demand while gaining some domestic demand—but not nearly enough to compensate for their losses and maintain typical volumes. The scenic hotels, however, buoyed by increased domestic demand, reported roughly the same occupancy levels in 2020 as in previous years.

As shown in Figure 2, independent hotels had a slightly higher percentage of international visitors than chain hotels from 2017 to 2019 as well as in 2020 when the hotels become much more dependent on domestic visitors.

Table 1.
Count of hotels by type and size

	Hotel size				
Hotel type	A. Small (<100) rooms)	B. Medium (100-300) rooms)	C. Large (300-500) rooms)	D. Very large (>500) rooms)	Total
City - Chain	3	12	6	4	25
City - Independent	4	12	2	0	18
Scenic - Chain	1	7	1	0	9
Scenic - Independent	4	4	0	0	8

Source(s): Table by authors

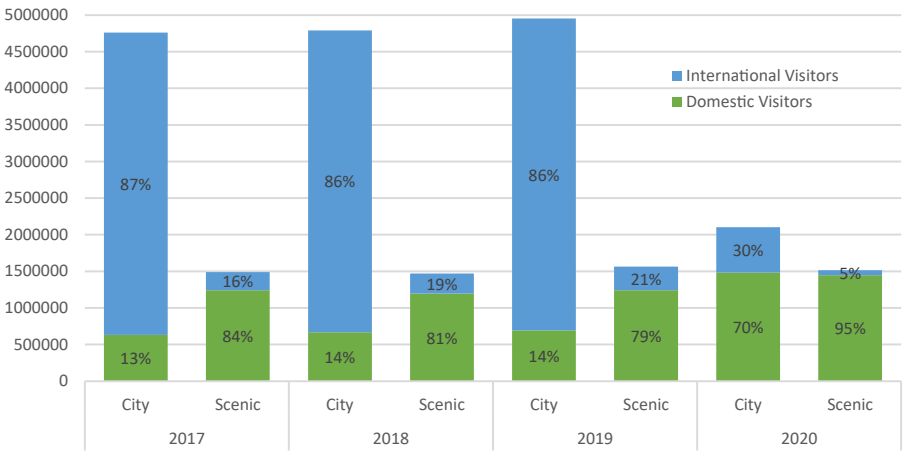
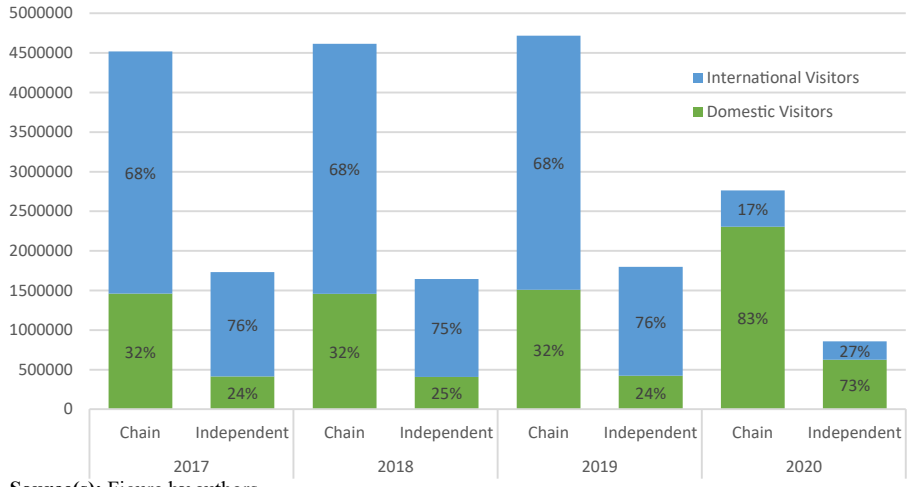


Figure 1.
Visitors to city and scenic hotels in 2017 through 2020

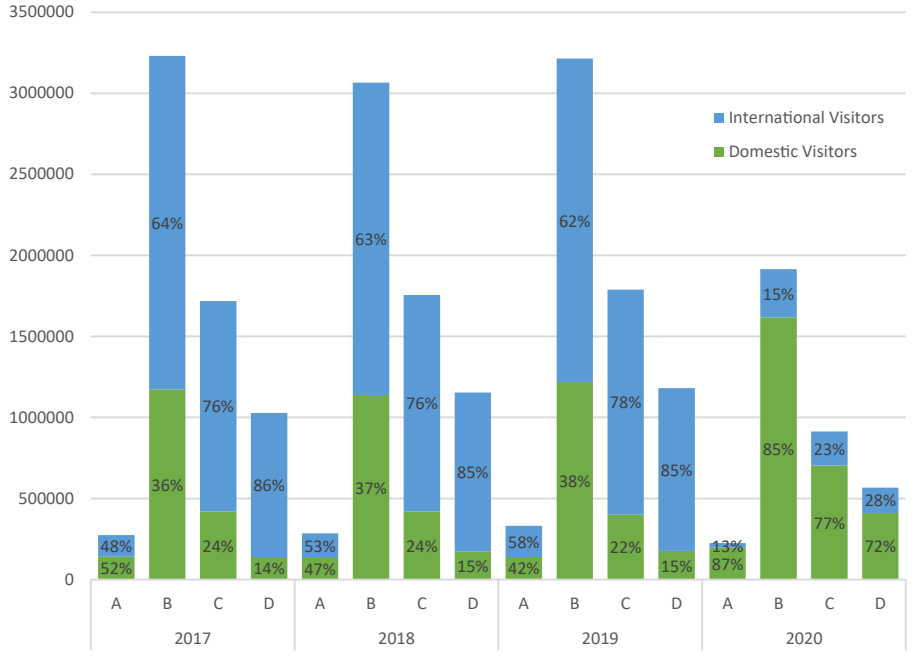
Source(s): Figure by authors

Referring to Figure 3, the percentage of visitors leans more toward international as the hotel size gets larger, in all years.



Source(s): Figure by authors

Figure 2.
Visitors to chain and domestic hotels in 2017 through 2020



Note(s): A is smallest, and D is largest

Source(s): Figure by authors

Figure 3.
Visitors by hotel size in 2017 through 2020

To gain more insight into how the hotels responded to the pandemic shutdowns, a MPI was computed for each hotel. This index value was then decomposed into efficiency change and technological change. Since MPI is used here as a year-over-year comparison, indexes were computed for 2018 in reference to 2017, 2019 in reference to 2018, and 2020 in reference to 2019. The data were balanced and paneled. We were especially interested in how productivity changed under the pressures of social distancing, increased cleaning requirements, and a greatly reduced international customer pool.

Variables

As noted before, MPI computations incorporate DEA in this study. Our method compares all of the hotels and implicitly develops a productivity frontier for the two points compared in time. The method determines how much the frontier has improved or regressed over the two periods being compared and also determines whether each hotel has come closer to the frontier or moved farther away. If productivity regression has occurred then it can be decomposed into managerial inefficiency, those shortcomings in efficiency that stem simply from managerial activity or inactivity, and scale inefficiency, which are inefficiencies that arise from operating at a non-optimal scale.

Several prior studies (e.g. Hu *et al.*, 2009; Neves & Lourenço, 2009; Chin *et al.*, 2013) use number of rooms and number of hotel employees across different departments including guest room, catering staff, cooks, maintenance crews and executives, as production function inputs in a Malmquist model. Barros and Alves (2004) indicate that the output is gauged by sales, number of guests and number of nights spent in the hotel. Referring to prior studies (e.g. Hu *et al.*, 2009; Neves & Lourenço, 2009; Chin *et al.*, 2013), room revenues include incomes from room rentals while food and beverage revenues include sales of food, snacks, alcohol, beverages in dining rooms, coffee rooms, banquets and night clubs. Other revenues include the leasing of store spaces (e.g. shops and conference meetings), retail sales for hotel-operated stores and concessions, ball court rentals and fees for various services and use of amenities such as spa, barbershop, beauty salons, telephone, pay-per-view movies, Internet access, etc.

The balanced panel data for 2017 through 2020 included the number of employees in each of three areas: room employees, food and beverage employees and other employees. Along with the number of rooms, these values served as the inputs for our productivity indices. On the output side, available data provided revenues in three subdivisions: room revenue, food and beverage revenue, and other revenue as well as occupancy rate and number of domestic and international guests. Because occupancy rate was considered redundant given the number of rooms and the number of visitors (correlation = 0.77), it was omitted from the analysis. In our analysis, input variables include the number of rooms, room employees, food and beverage employees and other employees. Output variables are the number of domestic guests and international guests, room revenues, food and beverage revenues and other revenues. Hotels are categorized based on (1) their location (city or scenic), (2) management (independent or chain operation), (3) whether they were a quarantine hotel or not and (4) their size broken into four groups: small (<100 rooms), medium (100-300 rooms), large (300-500 rooms), or very large (>500 rooms).

Results

The productivity package for R (Dakpo, Desjeux, & Latruffe, 2018) was used to compute the various productivity change and efficiency measures. Table 2 summarizes the MPI values. The factor that led to the largest difference in MPI for the pandemic year was the location of the hotel. City hotels fared much worse than the scenic hotels. Further analysis of city and scenic hotels by type of management (chain versus independent) and by property size (i.e. number of guestrooms) also revealed differences which can be seen in Table 2.

The Malmquist indexes were decomposed into efficiency change and technological change. Table 3 shows the average efficiency change indices for each subdivision of the 60 hotels, and Table 4 reports the average technological change indices.

The indices suggest that in 2018 (pre-pandemic), the city hotels improved productivity slightly while scenic hotels lost ground in productivity. In 2019 (also pre-pandemic), productivity growth was healthy overall, with better growth in the scenic hotels and in the independent hotels. In 2020, the pandemic caused a calamitous drop in productivity for the city hotels and a less severe, but still significant, drop in productivity for scenic hotels. In 2020, chain hotels did somewhat better than independent hotels. Overall, size was not a dominant factor, but larger hotels did better than smaller hotels for the scenic hotels.

In the decomposition of the productivity index into efficiency change and technological change, it can be seen that the factor leading to poor productivity in 2020 was technological change. A regression in the technological frontier is indicated. It is important to understand what this means. It is highly doubtful that the hotels changed their equipment to less efficient versions or began doing automated processes manually. What appears as technological regress is actually two separate but related factors. First, the pandemic added new steps to typical processes, i.e. adding new cleaning activity and making already existing process steps less efficient through requirements like social distancing. This occurred without any accompanying increase in value (at the chargeable level) to the customer. Second, the drop in international demand led to more idle rooms and idle employees which also is expressed as technological regress. The number of international guests was an output in the Malmquist

	18 to 17	19 to 18	20 to 19
City, independent	0.98	1.09	0.41
City, chain	1.01	1.06	0.43
Scenic, independent	0.96	1.15	0.78
Scenic, chain	0.93	1.10	0.92
City, small	1.05	1.09	0.40
City, medium	0.97	1.07	0.42
City, large	1.02	1.06	0.43
City, very large	1.03	1.05	0.48
Scenic, small	0.96	1.10	0.74
Scenic, medium	0.93	1.15	0.92

Note(s): Because there was only 1 large scenic hotel and no very large scenic hotels, they are not included here
Source(s): Table by authors

Table 2. Malmquist productivity Indices, geometric average of hotels in each sub-category

	18 to 17	19 to 18	20 to 19
City, independent	1.00	1.02	0.84
City, chain	1.01	1.01	0.89
Scenic, independent	1.01	1.05	0.99
Scenic, chain	0.99	1.01	1.01
City, small	1.06	1.06	0.79
City, medium	0.99	1.00	0.87
City, large	1.02	1.02	0.89
City, very large	1.00	1.03	0.92
Scenic, small	0.97	1.04	1.01
Scenic, medium	1.01	1.03	1.02

Source(s): Table by authors

Table 3. Efficiency change, geometric average of hotels in each sub-category

model. Since this output decreased for all hotels, it is considered to be a frontier change rather than as a failure to achieve the frontier, which would have appeared as an efficiency change.

We also explored how individual hotels responded to the pandemic and how that impacted their productivity change. Some hotels removed guestrooms from inventory, reduced the number of employees, and/or shifted their reliance to non-room revenues. Specifically, our data analysis revealed that hotels that shifted to more food and beverage activity during the pandemic had a less severe productivity drop than those that did not make this shift. Our results also showed that if the number of employees or rooms was reduced then hotels realized stronger productivity numbers than those that took no action.

An interesting strategic move for city hotels was the increased focus on generating food and beverage revenues. City hotels, in general, generate a higher portion of their revenue from food and beverages, as seen in Table 5. And during non-pandemic times, they tended to earn as much from food and beverages sales per occupied room as from the room rate itself. Scenic hotels' food and beverage income per occupied room was half of what was generated from room rental revenue. During the pandemic year, city hotels doubled their food and beverage income per room, whereas for scenic hotels, it stayed roughly the same. In fact, due to this increase in food and beverage revenue, the average total revenue per occupied room at city hotels increased by 30% during the pandemic year. This was not enough, however, to make up for the large drop in international visitors. From the available data, it is not clear whether this increase in food and beverage revenues at city hotels was due to more aggressive marketing of the hotels' food and beverage offerings, a lack of other options (i.e. down the street) for the hotel guests, or a rise in to-go orders for residents in the surrounding community. Also note that the other income per occupied room doubled as well in city hotels in the pandemic year.

Table 4.
Technological change, geometric average of hotels in each sub-category

	18 to 17	19 to 18	20 to 19
City, independent	0.98	1.07	0.48
City, chain	1.00	1.05	0.49
Scenic, independent	0.95	1.10	0.79
Scenic, chain	0.94	1.09	0.91
City, small	0.99	1.04	0.51
City, medium	0.98	1.07	0.48
City, large	1.00	1.04	0.48
City, very large	1.03	1.02	0.52
Scenic, small	0.99	1.05	0.73
Scenic, medium	0.93	1.12	0.90

Source(s): Table by authors

Table 5.
Revenues per occupied room in city vs scenic hotels

	City hotels			Scenic hotels		
Year	ADR	Average Daily F&B Rev/Occ Rm	Average Daily Other Rev/Occ Rm	ADR	Average Daily F&B Rev/Occ Rm	Average Daily Other Rev/Occ Rm
2017	11.72	12.15	3.44	14.77	7.89	2.51
2018	11.55	12.09	3.52	14.32	7.74	2.36
2019	11.57	11.66	3.40	15.70	6.76	2.09
2020	9.34	23.78	6.10	15.83	7.56	2.60

Note(s): ADR = average daily rate, room income per occupied room per day
Average Daily F&B Rev/Occ Rm = Average Daily F&B Revenues/Occupied Rooms
Average Daily Other Rev/Occ Rm = Average Daily Other Revenues/Occupied Rooms
Source(s): Table by authors

Five hotels were designated as quarantine hotels. Quarantine hotels are government designated Taiwan hotels that implement special hygiene and safety measures and will accept quarantine guests. This was a small sample; thus, one should exercise caution when drawing conclusions. The average Malmquist index for the quarantine hotels was 0.57 compared to the lower index of 0.51 for the non-quarantine hotels. Technological change at the quarantine hotels was 0.53 compared to 0.58 for the non-quarantine hotels. Technical efficiency change at the Quarantine hotels was 1.08, as compared to 0.89 at the non-quarantine hotels. One hotel performed especially well during the pandemic with a calculated Malmquist index of 1.04, efficiency of 1.71, and technological change of 0.61—outperforming all other city hotels and strongly influences these results.

Discussion and conclusions

Insights from city (Taipei) and scenic international tourist hotels

Taiwan is known as an international tourist destination while enjoying growth in domestic tourism. Natural attractions and landscape features within cities and across the island draw people in to visit and explore all that the island, geography and culture have to offer. Tourism is vital to the Taiwanese economy. Pandemic-induced havoc led to a significant decline in the number of international visitors which resulted in precipitous declines in hotel occupancy rates and room revenue in 2020. Strategic responses from Taiwanese international tourist hotels involved reducing the number of employees, attracting more domestic visitors and focusing more on food and beverage revenue and other revenues. Our results showed that the standard deviation of technical efficiency for city hotels in 2020 was 0.29 for independent hotels versus 0.13 for city chain hotels. For scenic independent hotels, the standard deviation for technical efficiency was 0.44 compared to 0.25 for scenic chain hotels. The productivity of independent hotels was lower than chain hotels as the pandemic broke out in 2020, so there is more risk of inefficiencies with independent hotels as compared to chain hotels. The findings of this study reveal that chain hotels tended to perform better than independent hotels in both city and scenic areas during the time (2020) of this global outbreak. Our hotel data shows that several chain hotels in Taiwan are members of well-known international hotel groups such Hyatt and Marriott, and thus these chain hotels in Taiwan may get more resources (including people, capital, technology and facilities) from their parent company to develop better response strategies. Along with the response strategies, the chain hotels were able to better utilize the resources to standardize processes and procedures over their various branches in 2019–2020.

Specifically, the crisis caused a substantial decline in productivity and profitability for international tourist hotels in Taipei during the COVID-19 period. Compared to city hotels, findings also indicate that most international tourist hotels in scenic areas were able to maintain better productivity, including larger-sized scenic hotels. In addition, as part of Taiwan's safety requirements during the early stages of the COVID-19 outbreak period, travelers arriving in Taiwan had to complete a mandatory fourteen-day quarantine and a seven-day self-health management. In line with this perspective, transportation and traffic may be a restriction for tourists who needed to quarantine in Taiwan, and the restriction could be a main reason leading to huge growth in the number of domestic tourists who intend to visit various iconic sites during the pandemic. This could be a major reason that drives international tourist hotels in scenic areas to achieve stronger productivity in 2020 during the pandemic.

Managerial implications

To respond to the impacts of the COVID-19 pandemic, a few quarantine hotels in Taipei operated at reduced staff levels. Findings show that smaller-sized city hotels were able to

maintain better productivity when serving both quarantine visitors and domestic visitors. Thus, participating in the list of designated quarantine hotels could be considered as a strategic choice for small-sized city hotels to achieve better firm performance and offset declines in international tourism. On the other hand, strategic decisions involve plans to mitigate risk. In the case of the pandemic, a major risk is the loss of guests due to a mass transportation shutdown and closed borders, actions taken to slow the spread of the disease. Hotels that depend heavily on air travel and other forms of mass-transportation to bring guests to their locations assume a larger risk than hotels serving local and drive-to markets. Taiwan's scenic hotels were much better positioned when the pandemic occurred because they were not as dependent on international travelers as city hotels and reachable by private transportation. Consequently, their drop in demand was less exacerbated compared to city hotels. This study also noted that the strategic decision to operate independently versus under the guise of a major brand or chain increased performance and productivity risks during the pandemic.

The findings and managerial implications contained in this study provide important strategic considerations for hotel executives, especially when trying to plan for and mitigate any adverse effects of a future crisis or pandemic. Implementing a disciplined and ongoing environmental scanning program as part of the strategic planning process to forecast trends and identify forces of change to envision what could be in store for the future will allow hotel executives to conduct scenario planning and make strategic choices that will capitalize on opportunities and mitigate or thwart potential threats. While externalities are beyond anyone's control, what hotel leaders can control is how they respond to external events. With an effective environmental scanning program in place, they can anticipate external events, properly plan for them and then execute their plans when necessary. This preparedness will serve hotel organizations well in navigating change, overcoming challenges and creating a prosperous and sustainable future for their hotel businesses.

Limitations and future studies

This study relied on a data set collected from the Taiwan Tourism Bureau's *Report on Tourist Hotel Operations in Taiwan*. There are some limitations with these data. First, the report lists the number of employees but does not indicate if the number of hours employees worked was cut during the pandemic. Second, the report does not disclose the number of rooms removed from available inventory or hotel closures during the pandemic. Third, the report lacks sufficient data regarding pricing during the 2020 pandemic year. Our results indicate that ADR for city hotels dropped in 2020, which suggests that hotels may have resorted to discounting to generate demand or quite possibly that the mix of guests (for example, business vs non-business) or day of week proportions might have changed. Starting on June 15, 2022, the Central Epidemic Command Center (CECC) in Taiwan announced that it eased border restrictions and shortened the quarantine period to a three-day home quarantine and four-day self-initiated epidemic prevention, down from fourteen days.

This study, while instructive, only focused on Taiwanese hotels and looked at the latest data available at the time of this study. Given that the continuance of the pandemic into multiple years, future studies can collect more data to make a more longitudinal assessment. To allow for greater generalization beyond Taiwan, more hotels and geographic regions should be studied along with different types of hotels beyond city and scenic hotels. For example, how did COVID-19 impact hotel performance in countries that had less government regulation than Taiwan? Additionally, how did the pandemic impact hotel performance in countries that encompassed a much larger geographic area? There are a variety of directions for future work and any future studies could build on this present study by expanding the scope and performance data collected.

References

Abatecola, G., Belussi, F., Breslin, D., & Filatotchev, I. (2016). Darwinism, organizational evolution and survival: Key challenges for future research. *Journal of Management and Governance*, *20*(1), 1–17.

Albright, K. S. (2004). Environmental scanning: Radar for success. *Information Management Journal*, *38*(3), 38–45.

Alonso, A. D., Kok, S. K., Bressan, A., O'Shea, M., Sakellarios, N., Koresis, A., . . ., & Santoni, L. J. (2020). COVID-19, aftermath, impacts, and hospitality firms: An international perspective. *International Journal of Hospitality Management*, *91*, 102654.

Amitabh, M., & Gupta, R. K. (2010). Research in strategy–structure–performance construct: Review of trends, paradigms and methodologies. *Journal of Management and Organization*, *16*(5), 744–763.

Amuna, Y. M. A., Al Shobaki, M. J., & Naser, S. S. A. (2017). Strategic environmental scanning: An approach for crises management. *International Journal of Information Technology and Electrical Engineering*, *6*(3), 28–34.

Armstrong, C. E., & Shimizu, K. (2007). A review of approaches to empirical research on the resource-based view of the firm. *Journal of Management*, *33*(6), 959–986.

Ates, A., & Bititci, U. (2011). Change process: A key enabler for building resilient SMEs. *International Journal of Production Research*, *49*(18), 5601–5618.

Babatunde, B. O., & Adebisi, A. O. (2012). Strategic environmental scanning and organization performance in a competitive business environment. *Economic Insights-Trends and Challenges*, *64*(1), 24–34.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*(9), 1078–1092.

Banker, R. D., Chang, H., & Pizzini, M. J. (2004). The balanced scorecard: Judgmental effects of performance measures linked to strategy. *The Accounting Review*, *79*(1), 1–23.

Banker, R. D., Chang, H., & Feroz, E. H. (2011). Line item budgeting and production efficiency. *Journal of Theoretical Accounting Research*, *7*(1), 108–126.

Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. *Journal of Management*, *27*(6), 643–650.

Barros, C. P., & Alves, F. P. (2004). Productivity in the tourism industry. *International Advances in Economic Research*, *10*(3), 215–225.

Benczúr, D. (2005). Environmental scanning: How developed is information acquisition in Western European companies?. *Information Research: An International Electronic Journal*, *11*(1), n1.

Brown, N. A., Rovins, J. E., Feldmann-Jensen, S., Orchiston, C., & Johnston, D. (2019). Measuring disaster resilience within the hotel sector: An exploratory survey of Wellington and Hawke's Bay, New Zealand hotel staff and managers. *International Journal of Disaster Risk Reduction*, *33*, 108–121.

Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica*, *50*(6), 1393–1414.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429–444.

Chin, J. B., Wu, M. C., & Hsieh, L. F. (2013). Strategic planning of optimal resource allocation in response to global financial crisis–a study of international tourist hotels. *Applied Economics*, *45*(23), 3316–3328.

Cooper, W.W., Seiford, L.M., & Zhu, J. (Eds.) (2011), *Handbook on Data Envelopment Analysis*. Springer.

Dakpo, K. H., Desjeux, Y., & Latruffe, L. (2018). Productivity: Indices of productivity and profitability using Data Envelopment Analysis (DEA). R package version 1.1.0. Available from: https://CRAN.R-project.org/package=productivity/

DeMicco, F., Davies, O., & Cetron, M. (2019). *Strategic management for hospitality and travel: Today and tomorrow*. Dubuque, IA: Kendall Hunt Publishing Company.

Dess, C. (2005). *Strategic management formulation*. India: McGraw Hill International Book Company.

Fare, R., Grosskopf, S., & Lovell, C. (1994). *Production frontiers*. Cambridge: Cambridge University Press.

Fare, R., Grosskopf, S., & Margaritis, D. (2011). Malmquist productivity indexes and DEA. In *Handbook on data envelopment analysis* (pp. 127–149). Boston, MA: Springer.

Filimonau, V., Derqui, B., & Matute, J. (2020). The COVID-19 pandemic and organizational commitment of senior hotel managers. *International Journal of Hospitality Management*, *91*, 102659.

Fu, Y. K. (2020). The impact and recovering strategies of the COVID-19 pandemic: Lessons from Taiwan's hospitality industry. *Cogent Social Sciences*, *6*(1), 1829806.

Ghaharian, K., Abarbanel, B., Soligo, M., & Bernhard, B. (2021). Crisis management practices in the hospitality and gambling industry during COVID-19. *International Hospitality Review*, *35*(2), 171–194.

Goncharuk, A. G. (2019). Winemaking performance: Whether the crisis is over. *British Food Journal*, *121*(5), 1064–1077.

Gursoy, D., & Chi, C. G. (2020). Effects of COVID-19 pandemic on hospitality industry: Review of the current situations and a research agenda. *Journal of Hospitality Marketing and Management*, *29*(5), 527–529.

Haag, S. (2022). *The Fourth Industrial Revolution: What every college and high school student needs to know about the future*. Highlands Ranch, CO: Janus Press, LLC.

Hall, C. M., Scott, D., & Gössling, S. (2020). Pandemics, transformations and tourism: Be careful what you wish for. *Tourism Geographies*, *22*(3), 577–598.

Hallak, R., Assaker, G., O'Connor, P., & Lee, C. (2018). Firm performance in the upscale restaurant sector: The effects of resilience, creative self-efficacy, innovation and industry experience. *Journal of Retailing and Consumer Services*, *40*, 229–240.

Hamel, G., & Prahalad, C. K. (1994a). Competing for the future. *Harvard Business Review*, *72*(4), 122–129.

Hamel, G., & Prahalad, C. K. (1994b). Seeing the future first. *Fortune*, *130*(5), 64–69.

Herbane, B. (2019). Rethinking organizational resilience and strategic renewal in SMEs. *Entrepreneurship and Regional Development*, *31*(5-6), 476–495.

Hofer, C. W., & Schendel, D. (1978). *Strategy formulation: Analytical concepts*. St. Paul, MN: West Publishing Company.

Hsieh, L. F., & Lin, L. H. (2010). A performance evaluation model for international tourist hotels in Taiwan—an application of the relational network DEA. *International Journal of Hospitality Management*, *29*(1), 14–24.

Hu, J. L., Shieh, H. S., Huang, C. H., & Chiu, C. N. (2009). Cost efficiency of international tourist hotels in Taiwan: A data envelopment analysis application. *Asia Pacific Journal of Tourism Research*, *14*(4), 371–384.

Huang, Y., Mesak, H. I., Hsu, M. K., & Qu, H. (2012). Dynamic efficiency assessment of the Chinese hotel industry. *Journal of Business Research*, *65*(1), 59–67.

Huang, Y. H., Tu, Y. J., Strader, T. J., Shaw, M. J., & Subramanyam, R. R. (2019). Selecting the most desirable IT portfolio under various risk tolerance levels. *Information Resources Management Journal*, *32*(4), 1–19.

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

Im, J., Kim, H., & Miao, L. (2021). CEO letters: Hospitality corporate narratives during the COVID-19 pandemic. *International Journal of Hospitality Management*, *92*, 102701.

Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance*, *26*(4), 719–766.

Jiang, Y., & Wen, J. (2020). Effects of COVID-19 on hotel marketing and management: A perspective article. *International Journal of Contemporary Hospitality Management*, *32*(8), 2563–2573.

Jiang, Y., Ritchie, B. W., & Verreynne, M. L. (2019). Building tourism organizational resilience to crises and disasters: A dynamic capabilities view. *International Journal of Tourism Research*, *21*(6), 882–900.

Kanter, R. M. (2020). *Think outside the building: How advanced leaders can change the world one smart innovation at a time*. New York: Public Affairs.

Kazmi, A. (2008). *Strategic management and business policy* (3rd ed.). New Delhi: Tata McGraw Hill Publishing Company.

Kim, C., Kang, H. J., Chung, K., & Choi, K. (2021). COVID-19 and hotel productivity changes: An empirical analysis using malmquist productivity index. *Service Science*, *13*(4), 243–257.

Kraaijenbrink, J., Spender, J. C., & Groen, A. J. (2010). The resource-based view: A review and assessment of its critiques. *Journal of Management*, *36*(1), 349–372.

Malmquist, S. (1953). Index numbers and indifference surfaces. *Trabajos de estadística*, *4*(2), 209–242.

Mata, F. J., Fuerst, W. L., & Barney, J. B. (1995). Information technology and sustained competitive advantage: A resource-based analysis. *MIS Quarterly*, *19*(4), 487–505.

Mohammadi, A., & Ranaei, H. (2011). The application of DEA based Malmquist productivity index in organizational performance analysis. *International Research Journal of Finance and Economics*, *62*(6), 68–76.

Neves, J. C., & Lourenço, S. (2009). Using data envelopment analysis to select strategies that improve the performance of hotel companies. *International Journal of Contemporary Hospitality Management*, *21*(6), 698–712.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., . . . Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, *78*, 185–193.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, *41*(1), 127–150.

Norris, C. L., Taylor, S. Jr, & Taylor, D. C. (2021). Pivot! How the restaurant industry adapted during COVID-19 restrictions. *International Hospitality Review*, *35*(2), 132–155.

Oliver, D. (2020). About 80% of hotel rooms in the US are empty amid the coronavirus pandemic, new data says. Available from: https://www.usatoday.com/story/travel/hotels/2020/04/09/coronavirus-leaves-hotel-rooms-empty-str-data/5120441002/

Olsen, M. D., Murthy, B., & Teare, R. (1994). CEO perspectives on scanning the global hotel business environment. *International Journal of Contemporary Hospitality Management*, *6*(4), 3–9.

Olsen, M., West, J., & Tse, E. C. Y. (Eds.) (1998), *Strategic Management in the Hospitality Industry*. New York: John Wiley & Sons.

Pal, R., Torstensson, H., & Mattila, H. (2014). Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs. *International Journal of Production Economics*, *147*, 410–428.

Panos, C. (2013). The failure of foresight in crisis management: A secondary analysis of the mari disaster. *Technological Forecasting and Social Change*, *80*(9), 1657–1673.

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

Ragsdale, C. (2018). *Spreadsheet modeling and decision analysis: A practical introduction to business analytics* (8th ed.). Boston, MA: Cengage Learning.

Schrage, M. (1997). The squandered computer: Evaluating the business alignment of information technologies. *Harvard Business Review*, *75*(5), 178–181.

Sigala, M. (2020). Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. *Journal of Business Research*, *117*, 312–321.

Slywotzky, A. J. (1996). *Value migration: How to think several moves ahead of the competition*. Boston: Harvard Business School Press.

Taiwan Centers for Disease Control (2020). Prevention and control of COVID-19 in Taiwan. Available from: https://www.cdc.gov.tw/en/category/page/0vq8rsAob_9HCi5GQ5jH1Q

Templeton, A.J., Goonan, K., & Fyall, A. (2021). COVID-19 and its impact on visitation and management at US national parks. *International Hospitality Review*, *35*(2), 240–259.

Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research*, *130*(3), 498–509.

Tone, K. (2004). Malmquist productivity index. *Handbook on data envelopment analysis* (pp. 203–227). Boston, MA: Springer.

Tsai, M. C. (2021). Developing a sustainability strategy for Taiwan's tourism industry after the COVID-19 pandemic. *PLOS One*, *16*(3), e0248319.

Venkatraman, N., & Prescott, J. E. (1990). Environment-strategy coalignment: An empirical test of its performance implications. *Strategic Management Journal*, *11*(1), 1–23.

Venkatraman, N., Henderson, J. C., & Oldach, S. (1993). Continuous strategic alignment: Exploiting information technology capabilities for competitive success. *European Management Journal*, *11*(2), 139–149.

Wambua, J., & Omondi, M. (2016). Factors influencing the environmental scanning of organizations in manufacturing sector: A case study of Kenya breweries limited. *Strategic Journal of Business and Change Management*, *3*(2), 233–253.

Wang, F. C., Hung, W. T., & Shang, J. K. (2006). Measuring pure managerial efficiency of international tourist hotels in Taiwan. *The Service Industries Journal*, *26*(1), 59–71.

Wu, W. W., Lan, L. W., & Lee, Y. T. (2013). Benchmarking hotel industry in a multi-period context with DEA approaches: A case study. *Benchmarking: An International Journal*, *20*(2), 152–168.

Yamamoto, G., & Sekeroglu (2011). Crisis management in the Turkish Leather industry. *African Journal of Business Management*, *5*(8), 3212–3219.

Yarmohammadian, M. H., Alavi, A., Ahmadi, F., Fatemi, M., & Moghadasi, M. (2016). An investigation of the status of preparedness and crisis management restrictions in hospitals of Isfahan University of Medical Sciences. *International Journal of Health System and Disaster Management*, *4*, 58–62.

Further reading

Child, J. (1972). Organizational structure, environment and performance: The role of strategic choice. *Sociology*, *6*(1), 1–22.

Rockwell, S. (2019). A resource-based framework for strategically managing identity. *Journal of Organizational Change Management*, *32*(1), 80–102.

Corresponding author

Yu-Hsiang (John) Huang can be contacted at: john.huang@gcsu.edu