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Optimal subsidy policies of the Chinese cruise market under the impact of COVID-19

Jiaguo Liu, Aixiang Zhao, Yudan Kong, Junjin Wang *

School of Maritime Economics and Management, Dalian Maritime University, Dalian, 116026, China

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ABSTRACT
The spread of the COVID-19 pandemic has caused severe damage to the Chinese cruise market since 2020. It is crucial for the local government to reformulate the subsidy policy to respond to the changing environment. We propose a cruise supply chain system to investigate the choice of subsidy recipients and the setting of optimal subsidy levels with a budget-constrained government during the access restriction period and post-epidemic period. We find that in both periods, as long as the subsidy achieves the optimal level, either the cruise lines, the travel agency, or the passengers as recipients of the subsidy policy can maximize the market demand and recover the cruise market after the COVID-19 outbreak. However, as the budget increases, subsidizing passengers can improve the “low price dilemma” of the Chinese cruise market. Compared with the access restriction period, the local government should adjust the subsidy level in the post-epidemic period. Interestingly, the subsidy policy does not always positively impact the international cruise line’s profit in the post-epidemic period.

1. Introduction

With the continuous improvement of infrastructure and the layout of new ships, Asia-sourced cruise passenger numbers hit another record high in 2018 with 4.24 million (CLIA, 2018). Meanwhile, Mainland China maintained its dominance as the largest source market in Asia, accounting for 55.8% of all Asian passengers (Qian et al., 2019), and is becoming the most promising segment of the global cruise market. To further expand the market scale, local governments in the coastal cities of China have introduced policies to support the cruise economy (Wang et al., 2020), but there is no agreement on who should be subsidized. For example, (1) the Xiamen government subsidizes cruise lines at the rate of 200/250 RMB (31.48/39.35 USD) per person depending on the number of outbound passengers, but (2) the Haikou government subsidizes travel agencies at the rate of 50/100 RMB (7.87/15.74 USD) per person for organizing domestic/foreign tourists to take cruises at local ports. This paper is motivated by the different policy practices of local governments in coastal China. It is worth investigating whether the choice of subsidy recipients (cruise lines, travel agencies, or passengers) will change the subsidy effect.

However, the COVID-19 pandemic has caused severe damage to the cruise industry throughout the world since 2020. On January 20, 2020, the Diamond Princess cruise ship departed from Yokohama, Japan. During the voyage, it was affected by the COVID-19, and 712 tourists and crew members were infected. (Rocklov et al., 2020). In addition, cruise ships such as the Supreme Princess, Ruby Princess, Zaandam and Costa Atlantic were also affected by the COVID-19 pandemic. In March 2020, Carnival Cruise Lines, Royal Caribbean Cruise Lines, and Novelty Norwegian Cruise Line announced the complete suspension of their global itineraries. The combined market capitalization of the three major cruise lines evaporated to more than 50 billion USD in three months (Qian et al., 2020). At the same time, many countries restricted or suspended international travel to prevent the spread of the virus. In 2020, the scale of outbound travel by Chinese tourists reached 20.23 million, a year-on-year decrease of 86.9%. Currently, international cruise lines are still not allowed to resume operations in Mainland China. The COVID-19 pandemic is tricky because we have not had a similar global crisis since the emergence of the cruise industry in the 1960s. Taking Carnival Corporation as an example, it only achieved revenues of 5.595 billion USD in 2020, down 15.235 billion USD year-on-year, with a net loss of 10.236 billion USD.

In response to the design flaws revealed by the Diamond Princess, such as the space layout and air conditioning system, the cruise line invested much money to improve the safety and epidemic prevention of the cruise ship (Sun and Zhao, 2022), including (1) Each stateroom, crew room, and public areas are equipped with 100% fresh air...
circulation system. (2) Medical center with isolation wards. (3) Use a medical-grade disinfectant for high-frequency disinfection. (4) Strictly enforce health and safety standards for food procurement. The cruise ship epidemic prevention and control system has been dramatically improved within a year, and now Royal Caribbean Cruise Line has 16 ships that have resumed operations, covering the North American, European, and Asian markets, with overall capacity restored to 64%. However, international cruise lines are not allowed to enter the Mainland China market due to the epidemic control policies, but some local cruise lines’ ships, such as the Nanshai Dream has already achieved resumption. The president of MSC Cruises China said, “by the end of 2022, we will restart the operation of all MSC fleet cruise ships in phases.”}

2020 Hainan Province Cruise Industry Work Focus stated that “the relevant subsidy policy for cruise industry should be reformulated to achieve the recovery of the cruise market after the COVID-19 outbreak.” Policy incentives are crucial to the development of the emerging cruise market (Qu et al., 2020; Wang et al., 2020). The concerns motivate us to achieve the recovery of the cruise market after the COVID-19 outbreak. A relevant subsidy policy for cruise industry should be reformulated to cover the North American, European, and Asian markets, with overall capacity restored to 64%. However, international cruise lines are not allowed to enter the Mainland China market due to the epidemic control policies, but some local cruise lines’ ships, such as the Nanshai Dream has already achieved resumption. The president of MSC Cruises China said, “by the end of 2022, we will restart the operation of all MSC fleet cruise ships in phases.”

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Q1: What is the optimal subsidy policy for the local government during the access restriction period? Is the subsidy policy favorable? Is the fiscal budget binding?

Q2: How does the choice of the subsidy recipients influence the operational decisions of supply chain members?

Q3: In the post-epidemic period, when the international cruise line is allowed to enter the mainland China market, how will the government’s subsidy policy and the cruise lines' operational decisions change?

To answer the above questions, we construct a supply chain system consisting of a budget-constrained government, two cruise lines, a travel agency, and passengers. Considering the two recovery periods of the Chinese cruise market after the COVID-19 outbreak, we construct the following two scenarios: (1) Scenario A: Access restriction period. The international cruise line is not allowed to enter the Chinese market due to the epidemic control policy, and the local cruise line monopolizes the market; (2) Scenario B: Post-epidemic period. With the improvement of the epidemic prevention system, the COVID-19 pandemic was controlled. The international cruise line re-enters the Chinese market to compete with the local cruise line. Different from the studies of Sun et al. (2019) and Wang et al. (2020), the government’s fiscal budget for subsidies is also considered in our model. The main findings are summarized as follows:

First, in the access restriction period: (1) As the local cruise line’s operating cost increases, the government should also increase the subsidy level when reformulating the subsidy policy; (2) Pricing decisions of supply chain members are influenced by subsidy policies; (3) The government’s budget is binding; (4) Previous studies have argued that subsidy effects are influenced by the choice of subsidy recipients (Yu et al., 2018; Shen et al., 2021; Guo et al., 2021), while our conclusions suggest that when the government’s budget is at a low level, it does not matter who receives the subsidy as long as the optimal unit subsidy is realized. However, as the budget increases, subsidizing passengers can improve the ‘low price dilemma’ of the Chinese cruise market.

Second, in the post-epidemic period: (1) The government’s fiscal budget is still binding; (2) The optimal subsidy levels are uniquely defined, but the subsidy recipients are not unique; (3) The lack of innovation in cruise products, high operating costs, and the low popularity of “cruise culture” are the main problems to be solved by the international cruise line in the Chinese market; (4) Cruise ports with complete port facilities, abundant land tourism resources and sufficient financial budgets, such as Shanghai, Guangzhou, and Xiamen, are the preferred ports for the international cruise line to resume operations.

Finally, by comparing equilibrium solutions in two periods, we find that: (1) The resumption of the international cruise line can significantly expand the size of the cruise market and increase consumer surplus; (2) Compared with the access restriction period, the government should adjust the subsidy level in the post-epidemic period. Specifically, the subsidy level for the local cruise line (or its supply chain members) should be reduced, and the subsidy level for the international cruise line (or its supply chain members) should be increased to attract more high-value passengers.

The contributions of this paper are three-fold. First, with the goal of maximizing the demand of the local cruise market, we propose a subsidy allocation model that considers government budget constraints. Second, we mark off two periods of recovery for the Chinese cruise market under the impact of the COVID-19 pandemic, and obtain the optimal subsidy policy for the two periods. To the best of our knowledge, this paper is the first theoretical study to explore the reformulation of subsidy policy under the impact of COVID-19. Finally, our study characterizes the competition between the local cruise line and the international cruise line, which is rarely considered in previous studies. The result shows that there should not be a uniform subsidy level for the local cruise line and the international cruise line.

The remainder of this paper is organized as follows: The relevant literature is reviewed in Section 2. Section 3 presents the model setting of this study. In Section 4, we investigate the government’s optimal subsidy policy in the access restriction period. Section 5 presents the government’s optimal subsidy policy in the post-epidemic period. Section 6 compares the equilibrium solutions of the two periods by numerical simulation. In this section, we also compare total market demand, profits of supply chain members and consumer surplus before and after the subsidy to demonstrate the effect of the subsidy policy. Section 7 provides a summary of the paper’s conclusions. All proofs are provided in Appendix.

2. Literature review

The literature on the cruise industry development is closely related to our research. The cruise industry has become an important driving force for the transformation and development of coastal ports (Hobson, 1993). Wie (2005) characterized the cruise industry as an oligopoly and stated that the Stackelberg game model can be used to analyze the dynamic behavior of cruise lines. Vay et al. (2018) examined the promotion of cruise tourism to the Barcelona port through data such as GDP and employment opportunities. Given that the COVID-19 pandemic has dramatically impacted the development of the cruise industry, many scholars have conducted relevant research. Ito et al. (2020) investigated the relationship between cruise ship size and the number of COVID-19 confirmations. Sun and Zhao (2022) examined disease preventive measures and isolation measures on board against COVID-19 by the port States. Pan et al. (2021) investigated the attitudes of 759 consumers towards the cruise industry during the COVID-19 pandemic, and the results showed that cruise companies should increase investment in epidemic prevention and advertising to restore consumer trust and achieve market recovery. Thus, we characterize the investment in epidemic prevention in the model, and we argue that restoring consumer trust and increasing the penetration of the local cruise market are the main goals of government subsidies. In addition, these studies focused on mature cruise markets such as the Caribbean and the Mediterranean, and mainly studied the development characteristics and trends of the cruise industry through empirical methods.

Our work is also related to the studies on cruise supply chain management. The cruise supply chain refers to the chain formed around the cruise line that includes both material suppliers and travel agencies. Veronneau and Roy (2009) proposed that global procurement and bidding for major projects is necessary, which can significantly reduce the overall cost of the supply chain, and analyzed how to deal with the challenges faced in global procurement practices. Further, Gu and Russo (2011) reflected on stakeholder strategies to enhance value creation and suggested that the global value chain approach could be applied to the cruise industry. Qu et al. (2019) argued that incentive contracts effectively achieve a win-win situation for supply chain members. Wang et al. (2020) constructed a cruise material supply chain.
consisting of a cruise line and a material supplier, and discussed the impact of different subsidy policies on social welfare and the profit performance of supply chain members. Sun et al. (2019) focused on the cruise sales supply chain, established a pricing model based on a cruise company and a travel agency, and explored the impact of the choice of subsidy recipients on port profits. However, these studies were limited to the pricing decisions and profit performance of supply chain members in the monopoly scenario, and rarely considered the competition of cruise lines (Liu and Wang, 2019; Zhu et al., 2021) and government budget restrictions. Compared with previous studies, the model setting in this paper is more practical.

The third related literature stream is on government subsidy policies. Regarding the goal-setting of subsidy policies, existing studies are generally based on a specific practical context. Due to the potential occurrence of the Downs-Thomson Paradox after highway capacity expansion, Wang et al. (2017) designed transit subsidies (including cost and passenger subsidies) from government funding or road toll revenues to overcome the D-T paradox. Chen et al. (2020) optimized the government’s tax and subsidy policy implementation plan for a coastal transportation system with the goal of minimizing government financial expenditures. Yu et al. (2020) argued that donors can maximize the number of beneficiaries using solar lights by achieving optimal subsidy levels. Hu et al. (2022) examined the optimal container subsidies for shippers to promote intermodal transport involving waterways in a regional transport network. In addition, some studies set the goal of subsidy policies to improve social welfare or consumer welfare (Xia et al., 2019; Wang et al., 2020; Zhu et al., 2021). Regarding the research on the effect of subsidies, Li et al. (2020) showed that higher consumer surplus and social welfare are generated when the equilibrium state of the two ports is to adopt subsidies. Shen et al. (2021) suggested that by providing consumer subsidies, the government can increase the purchase of N95 masks and effectively curb the spread of COVID-19. Some scholars also argued that government subsidies may have adverse effects. For example, Wang et al. (2020) suggested that excessive subsidies to cruise lines will impose a heavy financial burden on the government, which is not conducive to developing the emerging cruise market. Qu et al. (2020) indicated that the undifferentiated subsidy strategy adopted by local governments is unhelpful. Zhu et al. (2021) argued that excessive subsidies in areas with high public transit accessibility can harm social welfare and transportation network companies’ profits. Regarding the choice of subsidy recipients, Yu et al. (2018) studied the optimal subsidy problem for “home appliances to the countryside”, and suggested that the government should only subsidize consumer- or manufacturer-specific programs to maximize consumer welfare if the retail price is exogenously/endogenously given. Sun et al. (2019) found that subsidizing cruise lines can only benefit the home port of cruise ships, while subsidizing travel agents can benefit other ports of call. Huang et al. (2020) explored the impact of manufacturer subsidies, consumer subsidies, and green credit on the profits of supply chain members and environmental performance. Guo et al. (2021) discussed the impact of two subsidy methods (subsidized suppliers or manufacturers) on preventing supply disruptions.

Last, the COVID-19 pandemic, as an unprecedented global public health emergency, has severely influenced the transportation sector (Rothengatter et al., 2021). Some scholars examined the effectiveness of traffic restrictions in curbing the spread of the COVID-19 (Zhao et al., 2021; Amankwah-Amoah, 2020). Tirachini and Cats (2020) argued that these restrictions, while significantly reducing the likelihood of virus transmission, also created significant challenges for the global transportation sector. Li et al. (2021) studied the impact of direct flight suspension and full entry suspension on the international connectivity of air transport networks. Zhang et al. (2020) concluded that the number of COVID-19 cases is significantly correlated with the frequency of high-speed rail. Other scholars researched the recovery of the transportation sector after the COVID-19 outbreak. Zhang and Tong (2021) investigated the economic effects of transportation investment after the epidemic, and the results showed that railway investment has a more positive economic driving effect than road investment and aviation investment. Zhou et al. (2021) proposed a new network efficiency measurement method to investigate the vulnerability of the global air transportation network. Narasimha et al. (2021) analyzed the negative impact of the COVID-19 pandemic on the Indian maritime sector, and formulated a long-term recovery strategy.

Different from the existing literature, our research fills the gaps by analyzing the choice of subsidy recipients and the setting of optimal subsidy levels for a budget-constrained government. Moreover, our research is closely connected with reality. After the COVID-19 outbreak, the Chinese cruise market needed to go through two periods of recovery: (1) The access restriction period, when local cruise lines monopolize the market; and (2) The post-epidemic period, when international cruise lines re-enter the Chinese market and compete with local cruise lines. We propose a stylized model of the two supply chain settings to investigate the government’s subsidy policies in the two periods, and analyze the influences of subsidy policies on the pricing decisions and profits of supply chain members.

3. Model description

Consider a cruise supply chain consisting of two cruise lines, a travel agency, and passengers. Due to China’s relevant outbound travel policy, the two cruise lines can only sell tickets through the commissioned travel agency (Qian et al., 2019; Sun et al., 2019). Therefore, different from the North American market, the travel agency has the pricing power for cruise tickets in the Chinese market. We use subscript \( i \) (\( i = 1, 2 \)) to denote the local cruise line and the international cruise line, respectively. The sequence of events is as follows:

First, given a fiscal budget, the government chooses to subsidize the cruise lines (\( s_{ci} \)), the travel agency (\( s_{ta} \)), or the passengers (\( s_{ps} \)) to maximize the demand in the local cruise market.

It is to be noted that, differently from Wang et al. (2020) and Guo et al. (2021), who take the maximization of social welfare as the goal of the subsidy policy, we argue that the goal of the local government to subsidize cruise operators is: Maximize the demand of the local cruise market with a limited fiscal budget. The reasons are as follows: (1) In 2018, the penetration rate of the Chinese cruise market was only 0.08%, which is much lower than the European (2%) and North American (3.2%) cruise markets. Because of the vital role of the cruise industry in promoting local economic development, it is crucial to maintain steady growth in cruise market demand; (2) The COVID-19 pandemic has caused severe damage to the cruise industry. Strong preventive measures by cruise lines and financial subsidies from policymakers are needed to restore consumer trust in cruise tourism; otherwise, it will have a significant negative impact on the long-term development of the cruise industry (Pan et al., 2021).

Second, considering the subsidy (\( s_{ci}, s_{ta}, s_{ps} \)), the cruise line \( i \) sells tickets to the travel agency at wholesale price \( p_{w} \). The unit operating cost of the cruise line \( i \) is denoted as \( c_{i} \) and its fixed epidemic prevention investment is denoted as \( f_{i} \) (e.g., ventilation system and isolation room renovation).

Next, given the wholesale price \( p_{w} \) and the subsidy (\( s_{ci}, s_{ta}, s_{ps} \)), the travel agency as the follower that sets the unit retail price \( p_{r} \) to maximize its profit.

Thereafter, market demand and passenger payments are realized. The willingness of passengers to buy the tickets from the local cruise line

\footnote{During the access restriction period, the government may place strict restrictions on the quantity of travel. Due to the low penetration rate of the Chinese cruise market (0.08%), we assume that the total number of trips will not exceed the government’s expectations.}
is denoted by $v_1$, which follows a uniform distribution $v_1 \sim [0, 1]$. And we use $v_2$ to denote passengers’ willingness to buy tickets from the international cruise line, where $v_2 = \delta v_1$ represents the international cruise line’s brand advantage ($\delta \geq 1$). We normalize the cruise market size to 1 (Wang et al., 2020). The utilities of passengers from the local/international cruise line tickets can be expressed as: $U_1 = v_1 - (p_1 - s_{p1})$ and $U_2 = \delta v_1 - (p_2 - s_{p2})$.

In particular, Fig. 1 shows two supply chain structures.

Scenario A: Access restriction period. The international cruise line cannot enter the Chinese market due to the epidemic control policy, and the local cruise line monopolizes the market.

Scenario B: Post-epidemic period. With the improvement of the epidemic prevention system and routine control mechanisms, the COVID-19 pandemic was controlled. The international cruise line enters the Chinese market to compete with the local cruise line.

4. Optimal subsidy policy in the access restriction period

4.1. Pricing decisions of the local cruise line and the travel agency

After the outbreak of COVID-19, only the local cruise line can sell tickets through the travel agency during the access restriction period, and we use superscript $A$ to denote the equilibrium solutions in this scenario. Passengers decide whether to buy tickets from the local cruise line based on their utilities. When $U_1 > 0$, the passenger will purchase a ticket from the local cruise line. Otherwise, the passenger will buy nothing. Therefore, the demand function of the local cruise line is $D^A = D_1^A = \int_{p_1 - s_{p1}}^{1} dv_1 = 1 - p_1 + s_{p1}$. Moreover, we can obtain the consumer surplus in scenario A: $CS^A = \int_{p_1 - s_{p1}}^{1} U_1(v_1)dv_1 = \int_{p_1 - s_{p1}}^{1} (v_1 - (p_1 - s_{p1}))dv_1$.

4.2. The local government’s subsidy decision

Given a fiscal budget $K$, the local government chooses to subsidize the local cruise line ($s_{c1}$), the travel agency ($s_{a1}$), or the passengers ($s_{p1}$) to maximize the local cruise line demand and recover the cruise market as soon as possible. Therefore, the government’s optimization problem is as follows:

$$\max_{(s_{c1}, s_{a1}, s_{p1})} D \quad s.t. \quad (s_{c1} + s_{a1} + s_{p1})D \leq K. \quad (5)$$

Using Eq. (4), we can derive the market demand $D^A_1 = \frac{1}{4}(1 - c_1 + s_{c1} + s_{a1} + s_{p1})$. Denoting $s^A \equiv s_{c1} + s_{a1} + s_{p1}$, we can obtain $D^A_1 = \frac{1}{4}(1 - c_1 + s^A)$. The government’s optimization problem can be reformulated as:

$$\max_{s^A} \frac{1 - c_1 + s^A}{4} \quad s.t. \quad \left\{ \begin{array}{l} \frac{1 - c_1 + s^A}{4} \leq K, \\ s^A \geq 0. \end{array} \right. \quad (6)$$

The Lagrange function of Eq. (6) is

$$L_1 = \frac{1 - c_1}{4} + \frac{s^A}{4} + m_1 \left( K - \frac{1 - c_1 + s^A}{4} \right) + m_2(s^A) \quad (7)$$

The K-T conditions for Eq. (7) are given by

---

\[ \text{Lemma 1. The impact of choosing different subsidy recipients on the pricing of supply chain members: (i) } \frac{\partial \pi^c_1}{\partial s_{c1}} < 0, \quad \frac{\partial \pi^a_1}{\partial s_{a1}} > 0, \quad \frac{\partial \pi^p_1}{\partial s_{p1}} > 0, \quad \text{and } \frac{\partial \pi^p_1}{\partial s_{a1}} < 0, \text{ (ii) } \frac{\partial \pi^c_1}{\partial s_{a1}} > 0, \quad \frac{\partial \pi^a_1}{\partial s_{c1}} < 0, \quad \text{and } \frac{\partial \pi^p_1}{\partial s_{c1}} < \frac{\partial \pi^p_1}{\partial s_{a1}}. \]

---

\[ \text{The willingness of passengers to purchase tickets is influenced by the cruise lines’ reputation, passengers’ valuation, media publicity and other factors.} \]
\[
\begin{align*}
\frac{\partial s_t}{\partial a} &= 0, m_1 \left( K - s_t \left( 1 - c_1 - s_t \right) \right) = 0, \\
K &\geq s_t \left( 1 - c_1 - s_t \right), m_1 \geq 0, \\
m_2 (s_t) &= 0, s_t \geq 0, m_2 \geq 0.
\end{align*}
\]

(8)

Proposition 1. In the access restriction period, (i) the government’s fiscal budget \( K \) is binding \( (\frac{\partial s_t}{\partial a} > 0 \text{ and } \frac{\partial s_t}{\partial c_1} > 0) \); (ii) The government’s optimal subsidy level \( s^{\ast} \) and the optimal demand \( D^{\ast} \) are

\[
s^{\ast} = \sqrt{\frac{(1 - c_1)^2 + 16K - (1 - c_1)}{2}} \quad \text{and} \quad D^{\ast} = 1 - c_1 + \sqrt{\frac{(1 - c_1)^2 + 16K}{8}}.
\]

The COVID-19 outbreak has increased the unit operating cost of the local cruise line \( c_1 \) (e.g., high-frequency cleaning and disinfection, high standard of food supply). Consequently, the government should also increase the subsidy level when reformulating the subsidy policy \( (\frac{\partial s_t}{\partial c_1} > 0) \). In addition, previous studies argued that the subsidy effect is influenced by the choice of the subsidy recipients (Yu et al., 2018; Shen et al., 2021). Proposition 1 suggests that for the local government, as long as the subsidy achieves the optimal level \( s^{\ast} \), either the local cruise line, the travel agency, or the passengers as the recipient of the subsidy policy can maximize the market demand and achieve the recovery of the cruise market after the COVID-19 outbreak. The possible reasons for the difference are: (1) The construction of the objective function. We believe that the local government subsidies to the cruise operators aim to maximize the demand with a limited fiscal budget. In contrast, previous studies tend to maximize social welfare as the goal of government subsidies; (2) We add constraint functions to consider the impact of government budget constraints.

Corollary 1. When the local government chooses to subsidize the local cruise line \( (s_1 = s^{\ast}) \)/travel agency \( (s_2 = s^{\ast}) \)/passengers \( (s_3 = s^{\ast}) \), the pricing decisions, profits of the supply chain members, and the consumer surplus are as follows:

\[
\begin{align*}
w_1^{\ast} &= \frac{3 + c - \sqrt{(1 - c_1)^2 + 16K}}{4}, \\
\rho_1^{\ast} &= \frac{7 + c_1 - \sqrt{(1 - c_1)^2 + 16K}}{8}, \\
\pi_1^{\ast} &= \frac{32}{1 - c_1 + \sqrt{(1 - c_1)^2 + 16K}^2}, \\
\pi_2^{\ast} &= \frac{64}{128 (c_1 = s_3^{\ast})}, \\
\pi_3^{\ast} &= \frac{64}{128 (c_1 = s_3^{\ast})}, \\
CS^{\ast} &= \frac{128}{128 (c_1 = s_3^{\ast})}.
\end{align*}
\]

Corollary 1 shows that during the access restriction period, the government’s choice of the subsidy recipient changes the pricing decisions of the supply chain members, where the changes in wholesale and retail prices are consistent with Lemma 1. Interestingly, there is no change in the profits of the supply chain members and the consumer surplus due to the combination of subsidy and pricing effect. Moreover, the investment in epidemic prevention should satisfy \( f_1 < \frac{1}{2} (1 - c_1 + \sqrt{(1 - c_1)^2 + 16K})^2 \); otherwise, the local cruise line operates at a loss.

However, it does not mean that the choice of the subsidy recipient is trivial. When the fiscal budget \( K \) is at a medium-to-high level, if the government subsidizes the local cruise line, motivated by the high level of subsidy, the cruise line will sell tickets below the cost to expand its market share. The policy will further exacerbate the “low price dilemma” in the Chinese cruise market and lead to an over-reliance on government subsidies by supply chain members, which is detrimental to the long-term development of the Chinese cruise market and the innovation and upgrading of cruise products. In Section 6.1, a numerical study will specify how the government chooses the recipient at different budget levels.

In summary, after the COVID-19 outbreak, the local cruise line monopolizes the market during the access restriction period. We can derive the following insights: (1) The government’s fiscal budget is binding; (2) The COVID-19 outbreak has increased the unit operating cost of the local cruise line, so the government should also increase the subsidy level when reformulating the subsidy policy; (3) Pricing decisions of supply chain members are influenced by subsidy policies; (4) When the government’s budget is at a low level, it does not matter who receives the subsidy as long as the optimal unit subsidy \( s^{\ast} \) is realized.

5. Optimal subsidy policy in the post-epidemic period

With the improvement of the epidemic prevention system and routine control mechanisms, the COVID-19 pandemic was controlled. The international cruise line re-enters the Chinese market to compete with the local cruise line. We use subscript \( i (i = 1, 2) \) to denote the local cruise line and the international cruise line, respectively. And we use superscript \( B \) to denote the equilibrium solution in scenario B.

5.1. Pricing decisions of the cruise lines and the travel agency

\[
\begin{align*}
w_1^{\ast a} &= \frac{1 + 3c_1 + \sqrt{(1 - c_1)^2 + 16K}}{4}, \\
\rho_1^{\ast a} &= \frac{7 + c_1 - \sqrt{(1 - c_1)^2 + 16K}}{8}, \\
\pi_1^{\ast a} &= \frac{32}{1 - c_1 + \sqrt{(1 - c_1)^2 + 16K}^2}, \\
\pi_2^{\ast a} &= \frac{64}{128 (c_1 = s_3^{\ast})}, \\
\pi_3^{\ast a} &= \frac{64}{128 (c_1 = s_3^{\ast})}, \\
CS^{\ast a} &= \frac{128}{128 (c_1 = s_3^{\ast})}.
\end{align*}
\]

Compared with the local Chinese cruise line, the international cruise line has a longer operating history and more innovative cruise products, which are more favored by passengers (Qian et al., 2019). For example, Royal Caribbean’s cruise ships have introduced the Baidu Shared WIFI.
Translator, which incorporates Baidu’s artificial intelligence and Tuge Technologies’ global cloud communication technology, opening up a unique experience of “intelligent translation + global Internet access”. MSC Cruises’ Legend will open up a route to the private islands of the Great Ocean Reef, so that tourists can enjoy the pure natural beaches. To capture the brand differences between the local cruise line and the international cruise line, we use $v_3 = \partial v_1$ to represent the international cruise line’s brand advantage ($\delta \geq 1$). In this section, we assume that $0 < c_1 < c_2 < 1$, indicating that the international cruise line needs higher operating costs to maintain its brand advantage. and we discuss the case that $0 < c_2 < c_1 < 1$ in Appendix D. All qualitative results still hold if the local cruise line has higher operating costs.

Given $p_0^1$ and $s_0$, the passenger will buy a ticket from the local cruise line if $v_1 > p_0^1 - s_0 (U_1 > 0)$ and $v_1 - p_0^1 + s_0 > v_2 - p_0^2 + s_0 (U_2 > U_1)$; the passenger will buy a ticket from the international cruise line if $v_2 > p_0^2 - s_0 (U_2 > 0)$ and $v_2 - p_0^2 + s_0 > v_1 - p_0^1 + s_0 (U_2 > U_1)$; otherwise, the passenger will buy nothing. Substituting $v_2 = \delta v_1$ into the above inequalities, the demand function $D_0^2$ can be expressed as:

$$D_0^2 = \int_{v_1^-}^{\partial v_2} \frac{1}{1 + \frac{v_1 - p_0^1 + s_0}{p_0^2 - s_0}} + (\frac{p_0^1 - p_0^2}{\delta - 1})^2$$

(9)

Moreover, we can obtain the consumer surplus in scenario B:

$$CS^B = \int_{v_1^-}^{\partial v_2} \frac{v_1 - p_0^1 + s_0}{1 + \frac{v_1 - p_0^1 + s_0}{p_0^2 - s_0}} + \frac{\partial v_1 - p_0^2 + s_0}{\delta - 1} \cdot$$

(10)

For any given $(s_1, s_2, s_3)$ and $(s_4, s_5, s_6)$, the profit functions of the cruise lines and the travel agency can be described as follows:

$$\pi_1^a = (w_1^a + s_1 + c_1) \left(\frac{\partial (p_0^1 - s_0)}{\delta - 1} + \frac{p_0^1 - p_0^2}{\delta - 1}\right) - f_1$$

(11)

$$\pi_2^a = (w_2^a + s_2 - c_1) \left(1 + \frac{p_0^1 - s_0}{\delta - 1}\right)$$

(12)

$$\pi_3^a = (p_0^1 - w_1^a + s_1) \left(\frac{\partial (p_0^1 - s_0)}{\delta - 1} + \frac{p_0^1 - p_0^2}{\delta - 1}\right) + (p_0^2 - w_2^a + s_2) \left(1 + \frac{p_0^1 - s_0}{\delta - 1}\right)$$

(13)

We are solving Eqs. (11)-(13) using reverse induction yields the optimal wholesale price $w_1^a$ and retail price $p_0^1$. Substituting $w_1^a$ and $p_0^1$ into the market demand function $D_0^2$ yields

$$D_0^2 = \frac{-c_2 + s_2 + s_3 + s_4 - 2c_2 + s_3 - 2s_4 - 2s_5 - s_6}{2(-1 + \delta)(1 - 4\delta)}$$

(14)

5.2. The local government’s subsidy decision

In the post-epidemic period, as the cruise lines compete in the market, the government’s optimization problem becomes:

$$\max_{D_1^a, D_2^a} D_1^a + D_2^a \text{ s.t.} \begin{cases} (s_1 + s_2 + s_3)D_1^a + (s_2 + s_4 + s_5)D_2^a \leq K, \\ s_1 \geq 0, \ s_2 \geq 0, \ s_3 \geq 0, \ s_4 \geq 0, \ s_5 \geq 0, \ s_6 \geq 0. \end{cases}$$

(16)

Substituting Eqs. (14) and (15) into Eq. (16) and denoting $s_i^a \equiv s_1 + s_2 + s_3$ and $s_i^b \equiv s_2 + s_4 + s_5$, we get $s_i^a = (4 - \frac{2}{\delta})D_1^a + 2D_2^a + c_1 - 1$ and $s_i^b = 2D_1^a + (-2 + 4\delta)D_2^a + c_2 - \delta$. The government’s optimization problem can be reformulated as:

$$\max_{D_1^a, D_2^a} D_1^a + D_2^a \text{ s.t.} \begin{cases} \left(\frac{4 - 2}{\delta}\right)D_1^a + 2D_2^a + c_1 - 1 \geq 0, \ \left(\frac{4 - 2}{\delta}\right)D_1^a + 2D_2^a + c_2 - \delta \geq 0. \end{cases}$$

(17)

The Lagrange function of Eq. (17) is

$$L_2 = D_1^a + D_2^a$$

(18)

Proof. See Appendix A.

Lemma 2. In the post-epidemic period, when the government’s budget is minimal (0 < K < K), all the subsidy funding should be subsidized to the local cruise line (or its supply chain members), where $K = \frac{\delta(-1 + c_2 + c_3(-1 + c_2 + c_2) + 2c_3)}{8(-1 + \delta)(1 - 4\delta)}$.

The government’s optimal subsidy level $d_i^a$ for the cruise line i is:

3 Before the COVID-19 outbreak, the local government implemented a unified subsidy level for local cruise lines and international cruise lines. We think that given the competition between them, differentiated subsidy levels should be implemented in the post-epidemic period.
The governments of Chinese coastal cities intensively released supportive policies in 2018-2019, increasing the funds used for cruise industry subsidies. **Lemma 2** is inconsistent with the current status of the Chinese cruise market, but it can provide a reference for other cruise markets in the growth period. Therefore, we focus on the subsidy policy at the normal budget level \( K \geq \max \{ 0, K \} \).

**Proposition 2.** When the budget \( K \) satisfies \( K \geq \max \{ 0, K \} \),

(i) If \( 1 \leq \delta < \frac{2}{3} \) and \( \frac{1 - \delta}{2} c_2 < c_1 < 1 \), \( 0 < c_1 < 1 - c_2 + \delta (1 + 2 c_2 - 2 \delta) \), and \( \max \{ 0, K \} \leq K \leq \bar{K} \), the international cruise line will exit the market again, i.e., \( D^*_2 = 0 \), and the game changes to the local cruise line monopoly model in scenario \( A \), where \( K = \delta c_1^2(1 + 2 c_1^2(2 c_1^2 - 1) + (\delta - 1)^2(1 + 2 \delta - 2 c_1(1 - c_1)(1 - \delta^2)) \).

(ii) If \( c_2 - c_1 > 1 - \delta > 0 \), or \( c_2 - c_1 < \delta - 1 \) and \( \frac{\delta}{1 + \delta} c_2 \leq c_1 \leq \frac{\delta}{1 + \delta} (1 - c_2) \), or \( \max \{ 0, 1 + \delta \} \leq c_1 \leq 2 \), or \( \delta \geq 2 \), the cruise lines compete in the market, i.e., \( D^*_1 > 0 \) and \( D^*_2 > 0 \), and the government’s budget \( K \) is binding \( \frac{\partial D^*_1}{\partial K} > 0 \) and \( \frac{\partial D^*_2}{\partial K} > 0 \). The government’s optimal subsidy level \( s^*_1 \) and the corresponding demand \( D^*_1 \) are:

\[
D^*_1 = \frac{\delta (1 + \delta^2 (3 - 2 \delta) + c_2 (1 - \delta) (1 + 2 \delta + \delta c_1 - 2 \delta - 4 \delta^2))}{4 (-1 + \delta)^2 (1 + 2 \delta + 8 \delta^2)}
\]

\[
D^*_2 = \frac{\delta (1 + \delta^2 (3 - 2 \delta) + c_2 (1 - \delta) (1 + 2 \delta + \delta c_1 - 2 \delta - 4 \delta^2))}{4 (-1 + \delta)^2 (1 + 2 \delta + 8 \delta^2)}
\]

\[
s^*_1 = \frac{-1 + c_1 + \delta (3 - 3 c_1 - 2 \delta + 2 c_1 \delta)}{2 (-1 + \delta)^2 (1 + 2 \delta)}
\]

\[
s^*_2 = \frac{-c_2 - 3 c_2 \delta^2 + (3 + 2 c_2) \delta^3 - 2 \delta^4}{2 (-1 + \delta)^2 (1 + 2 \delta)}
\]
Compared with the market demand $D^A$ in the access restriction period, we have $D^B_1 + D^B_2 > D^A$.

Cruise ships such as Norwegian Joy, Mariner of the Seas, and Sapphire Princess exited the Chinese market in 2018 (Qian et al., 2019). Proposition 2(i) helps avoid the recurrence of such incidents in the post-epidemic period. After resuming the shipping, the international cruise line should pay attention to the following points in operating in China.① Cruise products are not innovative enough to form brand advantages. Since the “THAAD incident”, the “China-South Korea” cruise route has permanently been closed, and the existing routes are not attractive enough for Chinese tourists. Therefore, in the post-epidemic period, the international cruise line should combine Chinese culture and use themes such as festivals and social customs to create brand differentiation and fully tap the potential of the Chinese market.② High operating costs and slow popularization of “cruise culture”. As the main force of cruise consumption, older people regard luxury cruise ships only as a kind of comfortable marine transportation and rarely make secondary consumption on the cruise, which significantly reduces the profitability of cruise ships. Faced with high operating costs, the Norwegian Joy left China for Alaska in 2018. Therefore, how to promote “cruise culture” and increase the appeal of cruise tourism to young people will become an urgent issue for the international cruise line in the post-epidemic period (Sun et al., 2014; Qian et al., 2019).③ The government’s budget is constrained. As a result, cruise ports with complete port facilities, abundant land tourism resources and sufficient financial budgets, such as Shanghai, Guangzhou, and Xiamen, are the preferred ports for the international cruise line to resume operations.

Similar to Proposition 1, Proposition 2(ii) suggests that the optimal subsidy levels $(s^*_B1, s^*_B2)$ are uniquely defined in the post-epidemic period, but the subsidy recipients are not unique. Proposition 3(iii) further compares the total market demand in the two scenarios, pointing out that the competition upstream of the supply chain will increase the total market demand, i.e., $D^B_1 + D^B_2 > D^A$. The government should liberalize the international cruise ships access policy and accelerate the
resumption of international cruise lines in mainland China. In addition, we investigate the pricing decisions and profits of the supply chain members and the consumer surplus when subsidizing different recipients. The results remain consistent with Corollary 1.

With the improvement of the epidemic prevention system and routine control mechanisms, the COVID-19 pandemic was controlled. The international cruise line re-enters the Chinese market to compete with the local cruise line. We can derive the following insights in scenario B: (1) The government’s fiscal budget is still binding; (2) The optimal subsidy levels ($s^*_1$, $s^*_2$) are uniquely defined, but the subsidy recipients are not unique; (3) The lack of innovation in cruise products, high operating costs, and the low popularity of "cruise culture" are the main problems to be solved by the international cruise line in the Chinese market; (4) Cruise ports with complete port facilities, abundant land tourism resources and sufficient financial budgets, such as Shanghai, Guangzhou, and Xiamen, are the preferred ports for the international cruise line to resume operations.

6. Numerical simulation

In this section, we will give three numerical examples to verify the effectiveness of the subsidy policy and analyze the government’s optimal subsidy policy after the COVID-19 outbreak. Through the analysis of the revenue structure of the two major cruise lines, Carnival and Royal Caribbean, and reference related literature (Wang et al., 2020; Sun et al., 2019), the values of the parameters are set as follows: $\delta = 1.5$, $c_1 = 0.5$, and $c_2 = 0.6$, which can ensure the decisions and profits of cruise lines and travel agency and the consumer surplus are positive. Section 6.1 shows how the government chooses the subsidy recipients at different budget levels. In Section 6.2, we compare the total market demand, supply chain members’ profits and consumer surplus before and after the subsidy to demonstrate the effect of the subsidy policy. Section 6.3 compares the optimal subsidy levels and subsidy effects between the two periods and provides suggestions for the government’s subsidy policy design after the COVID-19 outbreak. To avoid trivial discussions, considering the practice of the Chinese cruise market, we assume $K \geq \max \{0, K\}$ in the post-epidemic period (see Lemma 2).

Considering that the COVID-19 outbreak will increase the operating costs of cruise lines and that the international cruise line may have a distinct brand advantage, we also illustrate additional numerical results in Appendix C.

6.1. Choice of the recipients of subsidy

We focus on the question raised in Corollary 1 — how the government chooses the recipients at different budget levels. Taking the post-epidemic period as an example, we use $w$ and $p$ ($j = CR, AR, PR$) to represent the equilibrium solutions when subsidizing the cruise lines, the travel agency, or the passengers, respectively (Similar conclusions are obtained in the access restriction period). The details are shown in Appendix B.

Fig. 2 illustrates that when the budget $K$ is at a medium-to-high level ($K > 0.101$), if the cruise lines are the recipients of the policy, motivated by the high level of subsidies, they will sell tickets below the cost ($w^*_B - c < 0$) to realize market expansion. Specifically, due to the brand disadvantage, the local cruise line will establish its competitive advantage through a low wholesale price and ensure positive unit profit with the subsidy. As the budget increases, the international cruise line has to compete with the local cruise line at a low price ($\partial w^*_B / \partial K < 0$); otherwise, its market share will be divided. When the travel agency is the recipient, the subsidy still plays a role in ensuring positive unit profit (Fig. 3). On the one hand, the cruise lines and the travel agency rely excessively on the government’s subsidy. For mature cruise markets (e.g., European
and Caribbean), revenue incentives or cost subsidies are no longer common, and financial funds are used to develop sustainable tourism travel patterns (Perea-Medina et al., 2019), and improve the marine environment. Therefore, the over-reliance is not conducive to the transformation of the Chinese cruise market. On the other hand, the Chinese cruise market will fall into the “low price dilemma” for a long time, and the cruise line lacks the motivation to innovate products.

When the government subsidizes the passengers, the subsidy plays a direct role in increasing market demand, which is consistent with the goal of the policy. As shown in Fig. 4, the cruise lines and the travel agency increase the prices to maximize their profits, and the retail prices rise more rapidly than the wholesale prices due to the double marginalization (Lemma 1). Note that the mode of “Charter Cruises” puts the Chinese cruise market in a state of low-cost operation (Qian et al., 2019), and how to get out of the dilemma has become an academic concern, and our findings suggest that the change in subsidy recipients could help improve the situation. Compared with the abnormal development caused by subsidizing the cruise lines or the travel agency, subsidizing the passengers is more beneficial to the Chinese cruise market when the budget $K > 0.101$.

6.2. Impact of the subsidy policy

First, we investigate the total market demand, supply chain members’ profits and consumer surplus without the subsidy policy in the access restriction period (Scenario A). In this setting, the local cruise line and the travel agency conduct a two-stage Stackelberg game. We use the superscript $AW$ to denote the equilibrium solutions without the subsidy policy.

The profit function of the cruise line and the travel agency can be expressed as:

$$\pi^A_W = (p^A_W - w^A_W)(1 - p^A_W)$$ (19) and

$$\pi^T_W = (w^A_W - c)(1 - p^A_W) - f_i$$ (20)

By using backward induction, we can obtain:

$$w^A_W = \frac{1 + c}{2} - p^A_W = \frac{3 + c}{4}$$ (21)

$$\pi^A_W = \frac{(1 + c)^2}{16}, \pi^T_W = \frac{(1 + c)^2}{8} - f_i$$ (22)

$$D^{AW} = \frac{1 - c}{4} + 1$$ and $CS^{AW} = \frac{(-1 + c)^2}{32}$ (23)

**Proposition 3.** Comparing the equilibrium solutions before and after the subsidy in the access restriction period, we have (i) $D^{AW} > D^{AW}$; (ii) $\pi^A_W > \pi^A_W$ and $\pi^T_W > \pi^T_W$; (iii) $CS^{AW} > CS^{AW}$.

Fig. 6 indicates that in the access restriction period, the subsidy policy can effectively expand market demand and increase the penetration of the cruise market ($D^{AW} > D^{AW}$). For the local cruise line and the travel agency, the government’s subsidy is an incentive to improve their profit performance ($\pi^A_W > \pi^A_W$ and $\pi^T_W > \pi^T_W$). For passengers, the subsidy policy increases consumer surplus by reducing the price of tickets ($CS^{AW} > CS^{AW}$). Moreover, when $K < 0.375$, the market demand grows faster, which is in line with the government’s goal of launching the subsidy policy. However, as the budget increase, the increase in market demand slows down, and the profits of the cruise line and the travel agency increase more significantly. The conclusion is a guideline for allocating financial funds in some coastal cities.

As shown in Fig. 7, we continue to investigate the equilibrium solutions of scenario B (post-epidemic period) without the government’s subsidy (denoted by BW).

**Proposition 4.** Comparing the equilibrium solutions before and after the subsidy in the post-epidemic period, we have (i) $D^{BW} > D^{BW}$; (ii) $\pi^A_W > \pi^A_W$ and $\pi^T_W > \pi^T_W$; (iii) $CS^{BW} > CS^{BW}$; (iv) $\pi^T_B < \pi^T_W$, if $K < 0.39$; otherwise, $\pi^T_B > \pi^T_W$.

Interestingly, Proposition 4 shows that the subsidy does not always positively impact the international cruise line’s profit in the post-epidemic period. When $K < 0.39$, the subsidy reduces the international cruise line’s profit, which is caused by the negative effect of the decline in wholesale price than the positive effect of the increase in demand. Specifically, due to the higher level of subsidies for the local cruise line ($\pi^T_B > \pi^T_W$, Fig. 5), the international cruise line must set a lower wholesale price to ensure that its market share will not decrease. In the low-price competition, its brand advantage is weakened, which ultimately leads to a decline in its profit.

6.3. Design of the subsidy policy after the COVID-19 outbreak

The darkest moment has passed with the effective control of COVID-19, and the cruise industry may usher in a turning point in recovery in 2022. At present, Royal Caribbean Cruise Line has 16 ships that have resumed operations, covering the North American, European and Asian markets, with overall capacity restored to 64%. The president of MSC Cruises China said, “by the end of 2022, we will restart the operation of all MSC fleet cruise ships in phases.” The resumption of international cruise lines in mainland China is approaching. Therefore, this section provides suggestions for the government’s subsidy policy design by comparing the equilibrium solutions between the access restriction and the post-epidemic periods.

**Proposition 5.** In the post-epidemic period, the resumption of the international cruise line can increase the demand ($D^{BW} / D^{BW} > D^{BW}$, Fig. 8) and the consumer surplus ($CS^{BW} > CS^{BW}$, Fig. 9), and the government’s optimal subsidy level $s^*$ should be changed accordingly (Fig. 5).

2020 Hainan Province Cruise Industry Work Focus stated that “the relevant subsidy policy for cruise industry should be reformulated to achieve the recovery of the cruise market after the COVID-19 outbreak.” On the one hand, the policy should be flexible and change with the changing market environment. For example, the Nanhai Dream has achieved resumption, but it bears high operating costs and investments in epidemic prevention. Therefore, the Hainan government should
appropriately increase subsidies to revive the cruise industry. On the other hand, with the improvement of the epidemic prevention system and routine control mechanisms, the government should liberalize the international cruise ships access policy and accelerate the resumption of international cruise lines in mainland China. Although the invasion of international cruise lines will reduce the demand of local cruise lines \((D_B^P < D_A^P)\), the penetration rate of the Chinese cruise market will be improved \((D_B^P > D_A^P)\). In addition, the demand of local cruise lines is more sensitive to subsidies \((\frac{\partial CS}{\partial K} > \frac{\partial CS}{\partial K})\). With the increase of the government’s budget \(K\), the market share and profits of local cruise lines will continue to increase, which will help improve the local social welfare. Moreover, in the post-epidemic period, the government should reduce the level of unit subsidies to the local cruise line (or its supply chain members), i.e., \(s_1^* < s_2^*\), and increase the level of unit subsidies to the international cruise line (or its supply chain members) to attract more high-value passengers, but still need to satisfy \(s_1^* > s_2^*\).

Impacted by the COVID-19 pandemic, timely restoration of consumer confidence in cruise travel is also the focus of the government and cruise lines (Pan et al., 2021). Fig. 9 shows that consumer surplus increased significantly after the resumption of international cruise lines \((CS_B^* > CS_A^*)\). Furthermore, compared with the access restriction period, the consumer surplus in the post-epidemic period has increased more rapidly \((\frac{\partial CS}{\partial K} > \frac{\partial CS}{\partial K})\), which positively influences rebuiling consumer confidence.

7. Conclusion

After the COVID-19 outbreak, the Chinese cruise market needed to go through two periods of recovery: (1) The access restriction period, when local cruise lines monopolize the market; and (2) The post-epidemic period, when international cruise lines re-enter the Chinese market and compete with local cruise lines. We develop two three-stage Stackelberg game models to characterize the strategic interactions between the government, the cruise lines, and the travel agency. Firstly, we analyze the impact of the subsidy on the operational decisions of supply chain members and discuss how to improve the current “low price dilemma” in the Chinese cruise market. Secondly, we investigate how the government chooses subsidy recipients and sets the optimal subsidy levels at different budget levels. Thirdly, we compare the total market demand, supply chain members’ profits and consumer surplus before and after the subsidy to demonstrate the effect of the subsidy policy. Finally, we compare the optimal subsidy levels and subsidy effects between the two periods, and provide suggestions for the government’s subsidy policy design after the COVID-19 outbreak. The study yields the following key findings and management insights.

Our findings are instructive for local governments to reformulate their cruise subsidy policies after the COVID-19 outbreak. Regarding setting the optimal subsidy levels, as the improvement of routine control mechanisms, the government should redistribute subsidy funds. Specifically, the government should appropriately increase the subsidy level to revive the cruise industry in the access restriction period. In the post-epidemic period, the government should reduce the level of unit subsidies to the local cruise line (or its supply chain members), and increase the level of unit subsidies to the international cruise line (or its supply chain members) to attract more high-value passengers. Besides, the optimal subsidy level for the local cruise line is still higher than that for the international cruise line. Regarding the choice of subsidy recipients, subsidizing passengers is more beneficial to the Chinese cruise market development in both periods.

It is imperative to liberalize the international cruise ships access policy and realize the resumption of international cruise lines in mainland China. The cruise industry has played a significant role in driving the regional economy. Realizing the resumption of international cruise lines in the mainland market can effectively increase the penetration rate of the local cruise market and restore consumer confidence in cruise travel. Currently, the Mediterranean, Northern Europe, Middle East, and North America markets have restarted operations. As one of the countries that have achieved remarkable results in the prevention and control of the COVID-19 pandemic, China should learn from the experience of the mature cruise market and accelerate the establishment of a complete prevention system for cruise ships.

This study also provides insights for supply chain members. First, cruise ports with complete port facilities, abundant land tourism resources and sufficient financial budgets, such as Shanghai, Guangzhou, and Xiamen, are the preferred ports for the international cruise line to resume operations. To avoid cruise lines operating at a loss, investments in epidemic prevention should be less than a certain threshold. Second, in the post-epidemic period, the government’s subsidy may weaken the brand advantage of the international cruise line. Therefore, how to improve the innovation of cruise products and promote “cruise culture” becomes an urgent problem for the international cruise line in the Chinese market. Finally, regarding the operational decisions, when the government chooses to subsidize the cruise lines, they will maximize profits by reducing the wholesale prices to increase market demand. Similarly, the travel agency will take the following strategy to reduce the retail prices. When the recipient of the subsidy policy shifts to the travel agency, the profit-maximizing cruise lines transfer the benefits generated by the subsidy policy to themselves by increasing the wholesale prices of tickets. Moreover, the cruise lines and the travel agency choose to raise prices when the subsidy recipients shift to the passengers due to the double marginalization.

There are some limitations to this study. For instance, the government may limit the number of trips during the access restriction period. Does this conflict with the objectives of government subsidies? How would the time length of these periods affect the analysis results? In addition, this study focuses on the influence of price on passengers’ willingness to purchase tickets. In practice, passengers’ willingness to purchase tickets during the access restriction period is also influenced by the cruise lines’ reputation, passengers’ valuation, media publicity, and other factors. It is a very interesting topic to investigate the specific influence of these factors on passengers’ utility.

CRediT authorship contribution statement

Jiaguo Liu: Conceptualization, Formal analysis, Resources, Writing - review & editing, Supervision, Funding acquisition.
Aixiang Zhao: Investigation, Writing - original draft, Visualization, Writing - review & editing.
Yudan Kong: Methodology, Validation.
Junjin Wang: Conceptualization, Supervision, Validation, Writing - review & editing.

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Appendix A. Supplementary data

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