Marine tourism omnichannel coordination

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Abstract

Purpose – With the growing economic impact of e-commerce and the increasing trend of omnichannel mode, more considerate services can be provided to customers. This paper aims to explore the optimal practice of business strategies and enrich the research content of marine tourism omnichannel.

Design/methodology/approach – This paper studies the optimal practice of bundling pricing and service effort strategies between two tourism suppliers (TSs) and a travel agent (TA) who distributes complementary products in marine tourism omnichannel considering joint efforts of both sides. This study develops five models by Stackelberg and Nash game and introduces the revenue-sharing contract. All outcomes/results are analyzed and the corresponding numerical and sensitivity analyses are conducted to derive more managerial implications and business insights.

Findings – The main findings show that bundling price is directly proportional to inter-channel integration coefficient and service effort level coefficient, and inversely proportional to the price elasticity coefficient. TA tends to provide a higher level of service effort than TSs when TA plays a dominant role. Improving the service effort level unduly leads to a decline in profits. Moreover, TSs and TA can reach a win-win situation under the coordination mechanism and the marine tourism omnichannel can achieve the best performance.

Originality/value – A novel and useful approach towards joint equilibrium decisions of bundle pricing and service efforts in marine tourism omnichannel with complementary tourism products under different operational strategies is proposed.

Keywords Marine tourism omnichannel, Bundling pricing, Complementary products, Service effort level

Paper type Research paper

1. Introduction

With the rapid development of information and communication technology, the acquisition of tourism product information has become more prevalent and diversified. Tourists can easily search for information and buy tourism products through travel agents (TAs), especially online TAs (OTAs). Recently, large pure-play OTAs in China, such as Trip.com Group and LY.COM, have started to set up offline physical stores to expand the customer market. These stores provide tourists with thoughtful pre-sales consultation and experience services. In this way, TAs can track and accumulate the data associated with the whole shopping process of tourists, grasp the changes in customers that affect their decision-making and timely interact with tourists to improve their shopping experience. Therefore, a tourism omnichannel can be defined as a platform that seamlessly integrates the online experience, network management technology,

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marketing skills and other resources to sell various forms of travel services to customers through either virtual sites or tangible stores (Verhoef *et al.*, 2015; Long and Shi, 2017).

Bundling is the practice of marketing two or more products and/or services in a single package for a special price (Guiltinan, 1987). In the travel industry, TAs design and provide a variety of tourism to meet the diverse needs of tourists (Dong *et al.*, 2014). They usually combine two or more independent tourism products into a bundled tour package sold as a whole at a discounted price lower than the sum of separate products' prices. Bundle sale of tourism products is beneficial not only to tourists but also to products providers. On one hand, with all the needed services such as tour scenic, flight and accommodation provided, the shopping process for tourists is more convenient and traveling expenses can be saved (Kim *et al.*, 2009; Bujisic *et al.*, 2015). On the other hand, since the price of the bundled tour package is usually lower than the sum of separate tourism products prices, the bundled package tends to stimulate the demand of tourists, thus boosting the revenue of TA.

Marine tourism refers to all kinds of tourism and leisure activities carried out in coastal areas, offshore waters, deep seas and oceans. The long distance and special geographical location determine that it contains multiple tourism elements and consumption items, so the bundling strategy is particularly suitable for marine tourism. For example, bundling bathing beaches with buffets, or resort hotels with recreational activities such as surfing and diving are more popular than single marine tourist programs. The same service can be given to tourists and they just need to pay about two-thirds of the price when purchased separately.

A high level of service efforts in marine tourism omnichannel is a critical success factor with few studies. These efforts are made through the whole process of both online purchase and offline experience, involving online services such as information availability, security, the response speed of Internet platform, as well as offline services such as pre-sales consulting, the sophistication of infrastructure, touring experience and time spent waiting in line. Since service efforts are made by key stakeholders in marine tourism omnichannel with many different elements, formulating these efforts into quantitative functions are quite subtle and will be addressed in Section 3.

In marine tourism omnichannel, pricing with service effort level has become important factor affecting the purchase decisions of tourists. However, current marine tourism products in the market are an admixture of good and evil, such as low-price online group-buying that reduces the level of service effort and hidden consumption in tourism destinations. Such behavior has negative influences on the experience of tourists and the image of tourist operations. Therefore, it is meaningful to study how TA and TS determine the reasonable price and service effort levels to obtain the maximum profit. Specifically, this study intends to address the following research questions:

RQ1. How do TSs and TA determine their bundle pricing and service effort strategies to achieve the best performance in a marine tourism omnichannel?

RQ2. How does marine tourism omnichannel achieve Pareto improvement of the performance?

RQ3. What are the key factors that will affect the operational decisions and performance of marine tourism omnichannel and how do they affect it?

To answer these research questions, a two-echelon marine tourism omnichannel consisting of two TSs and a TA is designed for the game-theoretical modeling study, both TSs and TA jointly provide comprehensive service to tourists such as pre-sale consultation, scenario experience and tourist reception, etc. Through the construction of omnichannel mode, the price, service effort level and profits under decentralized and coordination situations are compared and analyzed. Finally, a revenue-sharing contract is designed to realize the coordination of marine tourism omnichannel.

The rest of this article is organized as follows. The corresponding literature is reviewed in Section 2. In Section 3, we define modeling notation and assumptions. Section 4 gives model formulations and solutions in the Stackelberg game, Nash game and Coordination scenarios, respectively. Then, the numerical examples and sensitivity analyses are conducted in Section 5. Section 6 discusses some managerial insights. Finally, we conclude this paper and propose some research prospects in Section 7.

2. Literature review

2.1 Service in tourism supply chain

Tourism supply chain is a network of tourism organizations which conduct different kinds of tourist activities and have different types of business relationships (Kaukal *et al.*, 2000; Alford, 2005; Zhang *et al.*, 2009). In the literature on service in the tourism supply chain, there are different views on the service supplier. Some scholars consider TS as the service supplier and the service in tourist destinations has a positive impact on customers' satisfaction and loyalty (Youn and Kim, 2017; Rahman and Zailani, 2017; Zhang *et al.*, 2019a, b). For example, in marine ecosystem services, the symbolic and aesthetic value and coastal and offshore leisure activities provided by the marine play a significant role in marine tourism (Culhane *et al.*, 2020).

Others hold the idea that TA, as the provider of comprehensive tourism services, involves in the tourism supply chain (Yildirim *et al.*, 2018). But in reality, an ideal touring experience cannot be achieved without TA and TS working together to provide a comprehensive service experience, such as the service quality of both TA and TSs in the tourism supply chain (Long and Shi, 2017), the joint green tourism service, pricing and advertising problem of TA and TS in a green tourism supply chain (Ma *et al.*, 2021) and a service supply chain composed of a hotel providing offline services and a platform responsible for pricing, online services and advertising investment (He *et al.*, 2022).

2.2 Omnichannel supply chain

Originating in the USA, the concept of omnichannel operations has developed rapidly in recent years. Relevant literature mainly focus on customers' experience, operational strategies and marketing effect, such as the impact of the integration quality of different channels on the omnichannel user's value experience (Shen *et al.*, 2018), the influencing factors of customers' channel choice intentions in the omnichannel retail environment (Xu and Jackson, 2019), customers' perception of channels on their choice (Singh and Jang, 2020), the influence of offline experience store, online virtual exhibition hall and inventory information disclosure on inventory decisions (Gao and Su, 2017), inventory and pricing decisions of omnichannel retailers supporting returns and cancellations (Zhang *et al.*, 2018), product pricing strategies under BOPS (Buy Online and Pick up in Store) mode (Cao *et al.*, 2016a, b; Niu *et al.*, 2019; Zhang *et al.*, 2019a, b; Kong *et al.*, 2020), the benefits of offline showrooms (Bell *et al.*, 2018), the mutual promotional effects of cross-channel subsidy policies on operational decisions and performances (Chen *et al.*, 2019) and the impact of adopting integrated management service on the performance of the assembly system with direct omnichannel (Chen and Peng, 2021).

2.3 Bundling pricing of complementary products

Research on the bundling strategy can be traced back to its advantages of it in market segmentation and price discrimination (Adams and Yellen, 1976; Schmalensee, 1984). As an attractive and profitable marketing strategy, numerous scholars have investigated bundling pricing from different perspectives, including customer behavior (Prasad *et al.*, 2017; Luo *et al.*, 2017; Gayer *et al.*, 2021), the types of products (Meyer and Shankar, 2016; Honhon and Pan, 2017; Jena and Ghadge, 2020; Taleizadeh *et al.*, 2020), demand uncertainty (Chen and

Zhang, 2015; Talebian *et al.*, 2020), limited stock (Cao *et al.*, 2016a, b; Gökgür and Karabatı, 2019) and market power (Pan and Zhou, 2017; Giri *et al.*, 2020).

Here, we are more concerned about the application of bundling strategies in complementary product pricing. Relevant literature can be divided into two categories: one is the products provided by the same supplier, such as the bundling pricing problem of a manufacturer selling multiple products through a retailer (Pan and Zhou, 2017), the impact of two platforms' bundling strategy on their respective enterprises (Giri *et al.*, 2020), the bundling strategy in a joint economic lot-sizing model with two complementary products (Hemmati *et al.*, 2021). And the other is the products provided by different suppliers, such as the bundling strategy with complementary products considering channel competition (Li *et al.*, 2018), and the pricing strategy for complementary products in a green supply chain (Shan *et al.*, 2020).

2.4 Marine tourism

Marine tourism includes coastal and maritime tourism. Coastal tourism includes tourism activities based on leisure activities such as swimming, surfing and sunbathing at the seashore, as well as land-based tourism near the seashore and suppliers and manufacturing industries related to these activities. Maritime tourism covers tourism activities based on water rather than land (e.g. boating, yachting, cruises and sailing) and includes the operation of land-based facilities, equipment manufacturing and services required for this part of the tourism industry (Gamage, 2016).

It is found that there are three major categories of studies on marine tourism. The first category is marine tourism resources and products, such as the classification of marine tourism products and resources (Gonzalez, 2021), the development strategies of marine cultural creative products (Qiu, 2020; Cao, 2020), the impact of marine tourism resources development (Wang and Zhang, 2019) and the marketing strategies and paths of marine green tourism (Shen, 2020). The second category is the impact of marine tourism on destinations. Most scholars believe that marine tourism activities cause ecological pollution to the destinations, such as air pollution, land pollution, deterioration of water quality and reduction of biodiversity (Burak *et al.*, 2004; Kurniawan *et al.*, 2016; Catlin and Jones, 2010; D'Lima *et al.*, 2016; Liu *et al.*, 2017). Other scholars believe that marine tourism activities can attract investment and stimulate the development of the local economy (Maria *et al.*, 2017; Liu and Cao, 2018). And the last one is sustainable development, such as the new development mode of marine tourism based on visual design (Pu and Meng, 2019) and big data mining technology (Yan, 2020), the study on the dependence and impact between human activities and marine ecosystem services (Bryhn *et al.*, 2020), and the challenges for marine tourism development (Tsilimigkas and Rempis, 2021).

Through relevant literature review, it is found that a few existing literature focuses on pricing strategies in marine tourism omnichannel. Besides, most of the service effort literature considered either the supplier or the retailer, but not both together. Different from previous research, this paper explores the impacts of the product bundling effects on the key supply chain decisions in the marine tourism omnichannel and explores the cooperative mechanism for it. This study will fill up the gap of the past research and provide new managerial insights to the marine tourism industry.

3. Modeling notations and assumptions

In this paper, we consider a marine tourism omnichannel consisting of two TSs and a TA who distributes products both online and offline. TSs are considered to provide complementary products to TA, respectively, and TA combines the two into a new product package.

According to Figure 1, two sales channels are involved. One is an offline channel set to attract tourists to consult and experience physical stores, and the other is an online platform where tourists can choose and compare marine tourism products they are interested in directly.

Tourism supplier 1 (TS1) provides product 1 at a unit cost of c_1 and tourism supplier 2 (TS2) provides product 2 at a unit cost of c_2. TS1 and TS2 sell their products to TA at the wholesale price w_1 and w_2, $w = w_1 + w_2$. Here, the subscript "i" $(i = 1, 2)$ represents different marine tourism products from two different TSs. The prices of two complementary products are p_1 and p_2, respectively. According to Lim *et al.* (2012), p_1 and p_2 are priced according to product cost segmentation, that is, $p_1 = p \bullet \frac{c_1}{c_1+c_2}$, $p_2 = p \bullet \frac{c_2}{c_1+c_2}$. The bundling price of these two products sold online or offline is p. The online channel generates certain costs such as advertising and website operations, and the offline channel needs to pay for rent, decoration and staff salaries. So, we denote the fixed operating costs of online and offline channels as c_{on} and c_{off}.

In addition, TSs and TA all provide a series of services to tourists, their service effort levels of them are denoted as e_1, e_2 and e_T, respectively. In practice, a strictly convex service function $c(e)$ is used to depict the unit cost of TSs' service effort levels. One form commonly adopted in previous literature is given as (Tsay and Agrawal, 2000): $c(e_i) = \frac{1}{2}k_i e_i^2$ $(i = 1, 2)$, where k_i is the service effort cost coefficient of TS. Similarly, the convex service function of TA is: $c(e_T) = \frac{1}{2}k_T e_T^2$, where k_T is service effort cost coefficient of TA.

The sales volume of tourism products online and offline can be expressed as follows:

$$q_{on} = \lambda a - \theta(p_1 + p_2) + g(e_T + e_1 + e_2) \tag{1}$$

$$q_{off} = (1 - \lambda)a - \theta(p_1 + p_2) + g(e_T + e_1 + e_2) \tag{2}$$

The total sales volume of tourism products is:

$$q = a - 2\theta(p_1 + p_2) + 2g(e_T + e_1 + e_2) \tag{3}$$

The parameter a represents the maximum potential market demand for marine tourism products. $\lambda(0 < \lambda < 1)$ represents online-channel market share. Correspondingly, $1-\lambda$ represents the market share of offline-channel. The parameter $b(b > 1)$ represents the price elasticity coefficient of tourism demand. The cross-price elasticity coefficient of tourism demand in different sales channels can be represented by the parameter $d(d > 1)$, and $b > d > 1$. Let $\theta = b - d$. Moreover, parameter g represents the impact coefficient of TSs' and TAs' service effort levels. To simplify the calculation, we set the coefficient of TSs' service effort level the same as TAs' (Table 1).

According to the above hypotheses, the profit function of TSs and TA can be described as follows:

$$\Pi_1 = (w_1 - c_1)q - \frac{1}{2}k_1 e_1^2 \tag{4}$$

$$\Pi_2 = (w_2 - c_2)q - \frac{1}{2}k_2 e_2^2 \tag{5}$$

$$\Pi_T = q(p - w) - c_{on}q_{on} - c_{off}q_{off} - \frac{1}{2}k_T e_T^2 \tag{6}$$

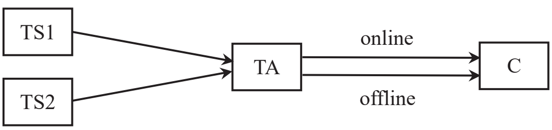


Figure 1.
The structure diagram of marine tourism omnichannel

Parameters	Explanations
a	The maximum potential market demand of marine tourism products
b	The price elasticity coefficient of marine tourism demand
c_1	The unit cost of the marine tourism product provided by TS1
c_2	The unit cost of the marine tourism product provided by TS2
d	The cross-price elasticity coefficient of marine tourism demand in different sales channels
g	The impact extent of TSs' and TAs' service effort level
k_1	The service cost coefficient of TS1
k_2	The service cost coefficient of TS2
k_T	The service cost coefficient of TA
q_{on}	The sales volume of marine tourism products online
q_{off}	The sales volume of marine tourism products offline
λ	The online channel market share of complementary tourism products
φ	The revenue-sharing ratio in a revenue-sharing coordination contract
θ	$b - d$
Decision variables	
e_1	The service effort level of TS1
e_2	The service effort level of TS2
e_T	The service effort level of TA
p	The bundle price of complementary marine tourism products
w_1	The wholesale price of the marine tourism product provided by TS1
w_2	The wholesale price of the marine tourism product provided by TS2

Table 1.
Explanations of parameters and decision variables

The profit function of marine tourism omnichannel can be described as follows:

$$\Pi = (p - c)q - c_{on}q_{on} - c_{off}q_{off} - \frac{1}{2}\left(k_1e_1^2 + k_2e_2^2 + k_Te_T^2\right) \tag{7}$$

4. Model formulations and solutions

In this section, six scenarios are considered in total. First, we construct several models to achieve the optimal price of marine tourism products and the maximum profit of TSs and TA by Stackelberg and Nash game. Then, a revenue-sharing contract is considered to coordinate the profit distribution of each member and improve the overall profit in marine tourism omnichannel.

4.1 TSs-leading stackelberg decision models

In TSs-leading Stackelberg decision models, the problem is analyzed as a Stackelberg game where TSs act as the leader and TA acts as the follower. Here we consider two scenarios. The first one is that TSs decide their service effort levels and the wholesale prices in sequence, and then TA decides its service effort level and the bundling price in sequence. Another is that TSs and TA decide their own service effort levels in sequence, and then they decide the wholesale prices and bundling prices for customers.

*4.1.1 TSs-TA sequential decision model (*SS*).* The decision sequence of TSs-TA sequential decision model (abbreviated as *SS*) is shown in Figure 2. First, TSs decide their service effort levels. Then, the wholesale prices for TA are decided by TSs to maximize their profits. Next, TA decides its service effort level both online and offline according to the pricing and service effort strategies of TSs. Finally, TA decides its bundling price.

When taking TSs-TA sequential decision model, the optimal profit function of marine tourism omnichannel can be formulated as:

$$\begin{cases}\begin{cases}\max\limits_{e_1}\Pi_1\\ \max\limits_{e_2}\Pi_2\end{cases}\\ s.t.\begin{cases}\begin{cases}\max\limits_{w_1}\Pi_1\\ \max\limits_{w_2}\Pi_2\end{cases}\\ s.t.\begin{cases}\max\limits_{e_T}\Pi_T\\ s.t.\max\limits_{p}\Pi_T\end{cases}\end{cases}\end{cases}$$

Solving this two-stage Stackelberg game, we can obtain the equilibrium TSs' service effort levels e_1^{SS} and e_2^{SS}, the equilibrium wholesale prices w_1^{SS} and w_2^{SS}, the equilibrium TA's service effort level e_T^{SS}, the equilibrium bundling price p^{SS} and the equilibrium demand online and offline q_{on}^{SS} and q_{off}^{SS}; on this basis, we can obtain the equilibrium profits of TS1, TS2 and TA and marine tourism omnichannel Π_1^{SS}, Π_2^{SS}, Π_T^{SS} and Π_{SC}^{SS} (Table 2). Superscript "SS" represents the solutions/outcomes in the model *SS*, the same as below.

*4.1.2 TSs-TA alternating decision model (*SA*).* The decision sequence of the TSs-TA alternating decision model (abbreviated as *SA*) is shown in Figure 3. First, TSs decide the service effort levels. Then, TA decides its service effort level both online and offline according to the service effort strategies of TSs. Next, the wholesale prices to TA are decided by TSs. Finally, TA decides its bundling price.

When taking TSs-TA sequential decision model, the optimal profit function of marine tourism omnichannel can be formulated as:

$$\begin{cases}\begin{cases}\max\limits_{e_1}\Pi_1\\ \max\limits_{e_2}\Pi_2\end{cases}\\ s.t.\begin{cases}\max\limits_{e_T}\Pi_T\\ s.t.\begin{cases}\begin{cases}\max\limits_{w_1}\Pi_1\\ \max\limits_{w_2}\Pi_2\end{cases}\\ s.t.\max\limits_{p}\Pi_T\end{cases}\end{cases}\end{cases}$$

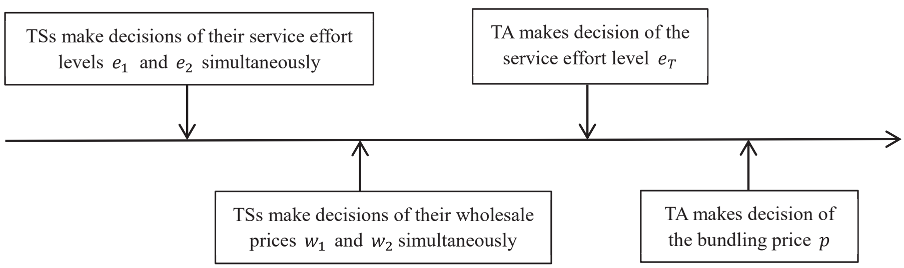


Figure 2.
The diagram of decision sequence in TSs-TA sequential decision model (*SS*)

Table 2.
The optimal solutions/outcomes in TSs-leading Stackelberg decision scenarios

	SS	SA
e_1	$\frac{gk_2k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{[9k_1k_2(\theta k_T-g^2)-2g^2k_T(k_1+k_2)]}$	$\frac{9\theta gk_T^2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]\cdot[k_2(9\theta k_T-g^2)^2-18\theta g^2k_T^2]+162\theta^2g^3k_T^4[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{[k_1(9\theta k_T-g^2)^2-18\theta g^2k_T^2]\cdot[k_2(9\theta k_T-g^2)^2-18\theta g^2k_T^2]-36\theta g^3k_T^2}$
e_2	$\frac{gk_1k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{[9k_1k_2(\theta k_T-g^2)-2g^2k_T(k_1+k_2)]}\ \frac{2g}{\theta k_2}$	$\frac{9\theta gk_T^2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]\cdot[k_1(9\theta k_T-g^2)^2-18\theta g^2k_T^2]+162\theta^2g^3k_T^4[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{[k_1(9\theta k_T-g^2)^2-18\theta g^2k_T^2]\cdot[k_2(9\theta k_T-g^2)^2-18\theta g^2k_T^2]-36\theta g^3k_T^2}$
e_T	$\frac{3gk_1k_2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2[9k_1k_2(\theta k_T-g^2)-2g^2k_T(k_1+k_2)]}$	$\frac{g[a-2\theta(c_1+c_2-c_{on}-c_{off})+2g(e_1^{SA}+e_2^{SA})]-3\theta g(c_{on}+c_{off})}{2(9\theta k_T-g^2)}$
w_1	$\frac{a+\theta(4c_1-2c_2-c_{on}-c_{off})+2g(e_1^{SS}+e_2^{SS})}{6\theta}$	$\frac{3k_T[a-\theta(2c_2-4c_1+c_{on}+c_{off})+2g(e_1^{SA}+e_2^{SA})]-2g^2c_1}{2(9\theta k_T-g^2)}$
w_2	$\frac{a+\theta(4c_2-2c_1-c_{on}-c_{off})+2g(e_1^{SS}+e_2^{SS})}{6\theta}$	$\frac{3k_T[a-\theta(2c_1-4c_2+c_{on}+c_{off})+2g(e_1^{SA}+e_2^{SA})]-2g^2c_2}{2(9\theta k_T-g^2)}$
p	$\frac{a(5\theta k_T-4g^2)+\theta(\theta k_T-2g^2)(2c_1+2c_2+c_{on}+c_{off})+2g(5\theta k_T-4g^2)(e_1^{SS}+e_2^{SS})}{12\theta(\theta k_T-g^2)}$	$\frac{15ak_T+(3\theta k_T-2g^2)(2c_1+2c_2+c_{on}+c_{off})+30gk_T(e_1^{SA}+e_2^{SA})}{4(9\theta k_T-g^2)}$
q_{on}	$\lambda a+\frac{6ag^2-\theta k_T[5a+\theta(2c_1+2c_2+c_{on}+c_{off})-2g(e_1^{SS}+e_2^{SS})]}{12(\theta k_T-g^2)}$	$\frac{a(12\lambda-5)}{12}+\frac{ag^2-9\theta k_T[\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_1^{SA}+e_2^{SA})]}{12(9\theta k_T-g^2)}$
q_{off}	$(1-\lambda)a+\frac{6ag^2-\theta k_T[5a+\theta(2c_1+2c_2+c_{on}+c_{off})-2g(e_1^{SS}+e_2^{SS})]}{12(\theta k_T-g^2)}$	$\frac{a(7-12\lambda)}{12}+\frac{ag^2-9\theta k_T[\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_1^{SA}+e_2^{SA})]}{12(9\theta k_T-g^2)}$
q	$\frac{\theta k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_1^{SS}+e_2^{SS})]}{6(\theta k_T-g^2)}$	$\frac{3\theta k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_1^{SA}+e_2^{SA})]}{2(9\theta k_T-g^2)}$
Π_1	$(w_1^{SS}-c_1)q^{SS}-\frac{1}{2}k_1{*}(e_1^{SS})^2$	$(w_1^{SA}-c_1)q^{SA}-\frac{1}{2}k_1{*}(e_1^{SA})^2$
Π_2	$(w_2^{SS}-c_2)q^{SS}-\frac{1}{2}k_2{*}(e_2^{SS})^2$	$(w_2^{SA}-c_2)q^{SA}-\frac{1}{2}k_2{*}(e_2^{SA})^2$
Π_T	$q^{SS}(p^{SS}-w^{SS})-c_{on}q_{on}^{SS}-c_{off}q_{off}^{SS}-\frac{1}{2}k_T{*}(e_T^{SS})^2$	$q^{SA}(p^{SA}-w^{SA})-c_{on}q_{on}^{SA}-c_{off}q_{off}^{SA}-\frac{1}{2}k_T{*}(e_T^{SA})^2$
Π_{SC}	$(p^{SS}-c)q^{SS}-c_{on}q_{on}^{SS}-c_{off}q_{off}^{SS}-\frac{1}{2}[k_1{*}(e_1^{SS})^2+k_2{*}(e_2^{SS})^2+k_T{*}(e_T^{SS})^2]$	$(p^{SA}-c)q^{SA}-c_{on}q_{on}^{SA}-c_{off}q_{off}^{SA}-\frac{1}{2}[k_1{*}(e_1^{SA})^2+k_2{*}(e_2^{SA})^2+k_T{*}(e_T^{SA})^2]$

Solving this two-stage Stackelberg game, we can obtain the equilibrium TSs' service effort levels e_1^{SA} and e_2^{SA}, the equilibrium TAs' service effort level e_T^{SA}, the equilibrium wholesale prices w_1^{SA} and w_2^{SA}, the equilibrium bundling price p^{SA} and the equilibrium demand online and offline q_{on}^{SA} and q_{off}^{SA}; on this basis, we can obtain the equilibrium profits of TS1, TS2, TA and marine tourism omnichannel Π_1^{SA}, Π_2^{SA}, Π_T^{SA} and Π_{SC}^{SA} (Table 2).

4.2 TA-leading Stackelberg decision models

In TA-leading Stackelberg decision models, the problem is analyzed as a Stackelberg game where TA acts as the leader and TSs act as followers. Here we consider two scenarios. The first one is that TA decides its service effort level and the bundling price in sequence, and then TSs decide their service effort levels and wholesale prices in sequence. Another is that TA and TSs decide their own service effort level in sequence, and then decide the bundling price and wholesale prices in sequence.

4.2.1 TA-TSs sequential decision model (AS). The order of TA-TSs sequential decision model (abbreviated as *AS*) is shown in Figure 4. First, TA decides the service effort level both online and offline. Then, the bundling price for customers is decided by TA. Next, TSs decide their service effort levels. Finally, the wholesale prices are decided by TSs.

When taking TA-TSs sequential decision model, the optimal profit function of marine tourism omnichannel can be formulated as:

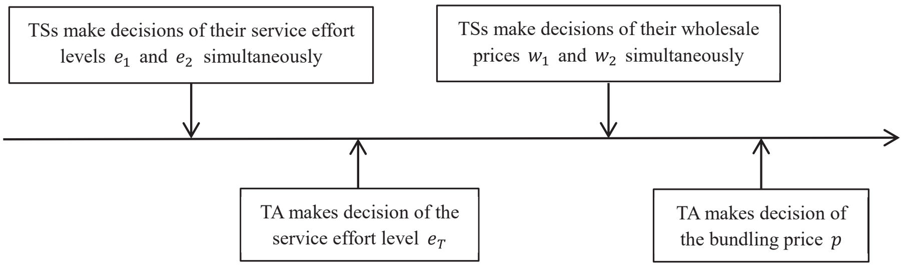


Figure 3. The diagram of decision sequence in TSs-TA alternating decision model (*SA*)

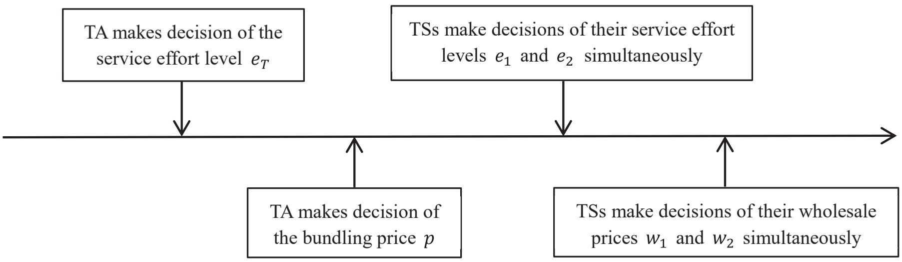


Figure 4. The diagram of decision sequence in TA-TSs sequential decision model (*AS*)

$$
\begin{cases}
\max\limits_{e_T} \Pi_T \\
s.t. \begin{cases}
\max\limits_{p} \Pi_T \\
s.t. \begin{cases}
\begin{cases}
\max\limits_{e_1} \Pi_1 \\
\max\limits_{e_2} \Pi_2
\end{cases} \\
s.t. \begin{cases}
\max\limits_{w_1} \Pi_1 \\
\max\limits_{w_2} \Pi_2
\end{cases}
\end{cases}
\end{cases}
\end{cases}
$$

Solving this two-stage Stackelberg game, we can obtain the equilibrium TAs' service effort level e_T^{AS}, the equilibrium bundling price p^{AS}, the equilibrium TSs' service effort levels e_1^{AS} and e_2^{AS}, the equilibrium wholesale prices w_1^{AS} and w_2^{AS} and the equilibrium demand online and offline q_{on}^{AS} and q_{off}^{AS}; on this basis, we can obtain the equilibrium profits of TS1, TS2, TA and marine tourism omnichannel Π_1^{SA}, Π_2^{AS}, Π_T^{AS} and Π_{SC}^{AS} (Table 3).

	AS	AA
e_1	$\frac{2g}{\theta k_1}$	$\frac{g}{18\theta k_1}$
e_2	$\frac{2g}{\theta k_2}$	$\frac{g}{18\theta k_2}$
e_T	$\frac{g\{\theta k_1 k_2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]+4g^2(k_1+k_2)\}}{2\theta k_1 k_2(3\theta k_T-g^2)}$	$\frac{g\{9\theta k_1 k_2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]+g^2(k_1+k_2)\}}{18\theta k_1 k_2(3\theta k_T-g^2)}$
w_1	$\frac{a+2ge_T^{AS}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12\theta}+\frac{g^2(k_1+k_2)}{3\theta^2 k_1 k_2}+c_1$	$\frac{a+2ge_T^{AA}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12\theta}+\frac{g^2(k_1+k_2)}{108\theta^2 k_1 k_2}+c_1$
w_2	$\frac{a+2ge_T^{AS}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12\theta}+\frac{g^2(k_1+k_2)}{3\theta^2 k_1 k_2}+c_2$	$\frac{a+2ge_T^{AA}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12\theta}+\frac{g^2(k_1+k_2)}{108\theta^2 k_1 k_2}+c_2$
p	$\frac{5a+10ge_T^{AS}+\theta(2c_1+2c_2+c_{on}+c_{off})}{12}+\frac{5g^2(k_1+k_2)}{3\theta^2 k_1 k_2}$	$\frac{5a+10ge_T^{AA}+\theta(2c_1+2c_2+c_{on}+c_{off})}{12\theta}+\frac{5g^2(k_1+k_2)}{108\theta^2 k_1 k_2}$
q_{on}	$\frac{(12\lambda-5)a+2ge_T^{AS}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12}+\frac{g^2(k_1+k_2)}{3\theta k_1 k_2}$	$\frac{(12\lambda-5)+2ge_T^{AA}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12}+\frac{g^2(k_1+k_2)}{108\theta k_1 k_2}$
q_{off}	$\frac{(7-12\lambda)a+2ge_T^{AS}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12}+\frac{g^2(k_1+k_2)}{3\theta k_1 k_2}$	$\frac{(7-12\lambda)a+2ge_T^{AA}-\theta(2c_1+2c_2+c_{on}+c_{off})}{12}+\frac{g^2(k_1+k_2)}{108\theta k_1 k_2}$
q	$\frac{a+2ge_T^{AS}-\theta(2c_1+2c_2+c_{on}+c_{off})}{6}+\frac{2g^2(k_1+k_2)}{3\theta k_1 k_2}$	$\frac{a+2ge_T^{AA}-\theta(2c_1+2c_2+c_{on}+c_{off})}{6}+\frac{g^2(k_1+k_2)}{54\theta k_1 k_2}$
Π_1	$(w_1^{AS}-c_1)q^{AS}-\frac{1}{2}k_1(e_1^{AS})^2$	$(w_1^{AA}-c_1)q^{AA}-\frac{1}{2}k_1(e_1^{A})^2$
Π_2	$(w_2^{AS}-c_2)q^{AS}-\frac{1}{2}k_2(e_2^{AS})^2$	$(w_2^{AA}-c_2)q^{AA}-\frac{1}{2}k_2(e_2^{AA})^2$
Π_T	$q^{AS}(p^{AS}-w^{AS})-c_{on}q_{on}^{AS}-c_{off}q_{off}^{AS}-\frac{1}{2}k_T(e_T^{AS})^2$	$q^{AA}(p^{AA}-w^{AA})-c_{on}q_{on}^{AA}-c_{off}q_{off}^{AA}-\frac{1}{2}k_T(e_T^{AA})^2$
Π_{SC}	$(p^{AS}-c)q^{AS}-c_{on}q_{on}^{AS}-c_{off}q_{off}^{AS}-\frac{1}{2}[k_1(e_1^{AS})^2+k_2(e_2^{AS})^2+k_T(e_T^{AS})^2]$	$(p^{AA}-c)q^{AA}-c_{on}q_{on}^{AA}-c_{off}q_{off}^{AA}-\frac{1}{2}[k_1(e_1^{AA})^2+k_2(e_2^{AA})^2+k_T(e_T^{AA})^2]$

Table 3.
The optimal solutions/ outcomes in TA-leading Stackelberg decision scenarios

*4.2.2 TA-TSs alternating decision model (*AA*).* The order of TA-TSs alternating decision model (abbreviated as *AA*) is shown in Figure 5. First, TA decides the service effort level both online and offline. Then, TSs decide the service effort levels. Next, the bundling price for customers is decided by TA. Finally, TSs decide the wholesale prices.

When taking TA-TSs alternating decision model, the optimal profit function of marine tourism omnichannel can be formulated as follows:

$$\begin{cases} \max\limits_{e_T} \Pi_T \\ s.t. \begin{cases} \begin{cases} \max\limits_{e_1} \Pi_1 \\ \max\limits_{e_2} \Pi_2 \end{cases} \\ s.t. \begin{cases} \max\limits_{p} \Pi_T \\ s.t. \begin{cases} \max\limits_{w_1} \Pi_1 \\ \max\limits_{w_2} \Pi_2 \end{cases} \end{cases} \end{cases} \end{cases}$$

Solving this two-stage Stackelberg game, we can obtain the equilibrium TAs' service effort level e_T^{AA}, the equilibrium TSs' service effort levels e_1^{AA} and e_2^{AA}, the equilibrium bundling price p^{AA}, the equilibrium wholesale prices w_1^{AA} and w_2^{AA} and the equilibrium demand online and offline q_{on}^{AA} and q_{off}^{AA}; on this basis, we can obtain the equilibrium profits of TS1, TS2, TA and marine tourism omnichannel Π_1^{AA}, Π_2^{AA}, Π_T^{AA} and Π_{SC}^{AA} (Table 3).

*4.3 TSs-TA nash decision model (*TN*)*

The decision sequence of TSs-TA Nash decision game (abbreviated as *TN*) is shown in Figure 6. First, TSs and TA decide the service effort level of themselves simultaneously.

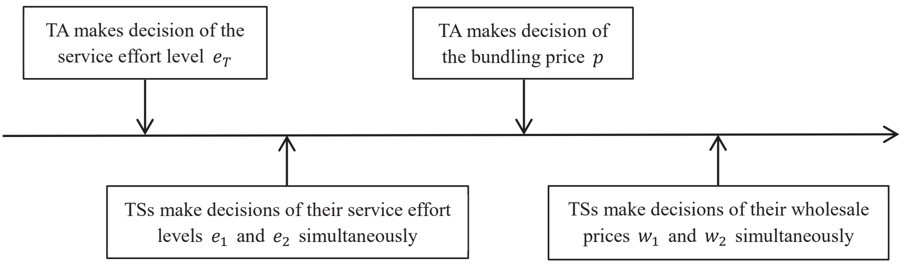


Figure 5. The diagram of decision sequence in TA-TSs alternating decision model (*AA*)

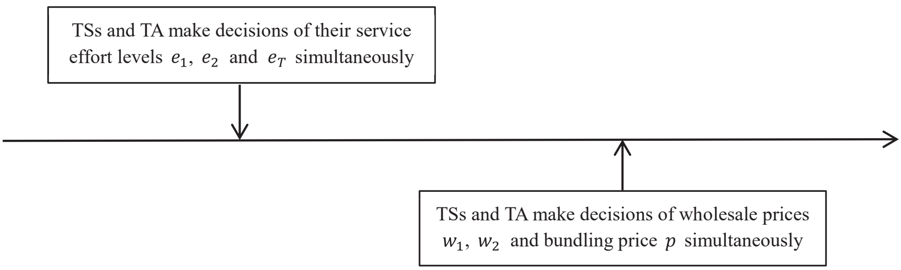


Figure 6. The diagram of decision sequence in TSs-TA Nash decision model (*TN*)

Then, TSs make decisions on the wholesale prices and TA makes the decision on the bundling price for customers simultaneously.

When taking TSs-TA Nash decision game, the optimal profit function of the marine tourism omnichannel can be formulated as follows:

$$\begin{cases} \begin{cases} \max\limits_{e_1} \Pi_1 \\ \max\limits_{e_2} \Pi_2 \\ \max\limits_{e_T} \Pi_T \end{cases} \\ s.t. \begin{cases} \max\limits_{w_1} \Pi_1 \\ \max\limits_{w_2} \Pi_2 \\ \max\limits_{p} \Pi_T \end{cases} \end{cases}$$

Solving this two-stage Stackelberg-Nash game, we can obtain the equilibrium TSs' and TAs' service effort levels e_1^{TN}, e_2^{TN} and e_T^{TN}, the equilibrium wholesale prices w_1^{TN} and w_2^{TN}, the equilibrium bundling price p^{TN} and the equilibrium demand online and offline q_{on}^{TN} and q_{off}^{TN}; on this basis, we can obtain the equilibrium profits of TS1, TS2 and TA and marine tourism omnichannel Π_1^{TN}, Π_2^{TN}, Π_T^{TN} and Π_{SC}^{TN} (Table 4).

4.4 Coordination decision model

4.4.1 Centralized decision model (C). In this scenario, TSs and TA make decisions together as a whole with the goal of maximizing the total profit. TA sells tourism products to travelers through online platforms or offline stores without considering the intermediate wholesale prices.

The decision sequence of a centralized decision model is shown in Figure 7. First, marine tourism omnichannel makes decisions on service effort levels simultaneously. Then, the marine tourism omnichannel decides the bundling price of the tourism package.

When taking a centralized decision, the optimal profit function of marine tourism omnichannel can be formulated as follows:

$$\begin{cases} \begin{cases} \max\limits_{e_1} \Pi_{SC}^{c} \\ \max\limits_{e_2} \Pi_{SC}^{c} \\ \max\limits_{e_T} \Pi_{SC}^{c} \end{cases} \\ s.t. \max\limits_{p} \Pi_{SC}^{c} \end{cases}$$

Solving this two-stage centralized decision model, we can obtain the equilibrium TSs' and TAs' service effort levels e_1^C, e_2^C and e_T^C and the equilibrium bundling price p^C.

4.4.2 Coordination decision model based on revenue-sharing contract (R). In order to optimize the profit distribution among supply chain members, a revenue-sharing coordination contract is considered to help TSs and TA achieve more profits in marine tourism omnichannel. We assume that TA shares a portion of the revenue with TSs, which is denoted by φ $(0 < \varphi < 1)$. That is to mean, TSs will obtain $1 - \varphi$ of revenues in addition to the revenues generated from wholesaling products to TA. At the end of the sales cycle, TS will

	TN	C
e_1	$\frac{gk_2k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2\{k_T[4\theta k_1k_2-g^2(k_1+k_2)]-g^2k_1k_2\}}$	$\frac{gk_2k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2[k_1k_2(\theta k_T-g^2)-g^2k_T(k_1+k_2)]}$
e_2	$\frac{gk_1k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2\{k_T[4\theta k_1k_2-g^2(k_1+k_2)]-g^2k_1k_2\}}$	$\frac{gk_1k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2[k_1k_2(\theta k_T-g^2)-g^2k_T(k_1+k_2)]}$
e_T	$\frac{gk_1k_2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2\{k_T[4\theta k_1k_2-g^2(k_1+k_2)]-g^2k_1k_2\}}$	$\frac{gk_1k_2[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{2[k_1k_2(\theta k_T-g^2)-g^2k_T(k_1+k_2)]}$
w_1	$\frac{4\theta k_1k_2k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{8\theta\{k_T[4\theta k_1k_2-g^2(k_1+k_2)]-g^2k_1k_2\}}+c_1$	$\frac{c_1}{c_1+c_2}\cdot\frac{2(1-\varphi)(c_1+c_2)-\varphi(c_{on}+c_{off})}{2}$
w_2	$\frac{4\theta k_1k_2k_T[a-\theta(2c_1+2c_2+c_{on}+c_{off})]}{8\theta\{k_T[4\theta k_1k_2-g^2(k_1+k_2)]-g^2k_1k_2\}}+c_2$	$\frac{c_2}{c_1+c_2}\cdot\frac{2(1-\varphi)(c_1+c_2)-\varphi(c_{on}+c_{off})}{2}$
p	$\frac{3a+\theta(2c_1+2c_2+c_{on}+c_{off})+6g(e_T^{TN}+e_1^{TN}+e_2^{TN})}{8\theta}$	$\frac{a+\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{C}+e_1^{C}+e_2^{C})}{4\theta}$
q_{on}	$\frac{(8\lambda-3)a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{TN}+e_1^{TN}+e_2^{TN})}{8}$	$\frac{(4\lambda-1)a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{C}+e_1^{C}+e_2^{C})}{4}$
q_{off}	$\frac{(5-8\lambda)a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{TN}+e_1^{TN}+e_2^{TN})}{8}$	$\frac{(3-4\lambda)a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{C}+e_1^{C}+e_2^{C})}{4}$
q	$\frac{a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{TN}+e_1^{TN}+e_2^{TN})}{4}$	$\frac{a-\theta(2c_1+2c_2+c_{on}+c_{off})+2g(e_T^{C}+e_1^{C}+e_2^{C})}{2}$
Π_1	$(w_1^{TN}-c_1)q^{TN}-\frac{1}{2}k_1(e_1^{TN})^2$	$(w_1^{C}-c_1)q^{C}-\frac{1}{2}k_1(e_1^{C})^2$
Π_2	$(w_2^{TN}-c_2)q^{TN}-\frac{1}{2}k_2(e_2^{TN})^2$	$(w_2^{C}-c_2)q^{C}-\frac{1}{2}k_2(e_2^{C})^2$
Π_T	$q^{TN}(p^{TN}-w^{TN})-c_{on}q_{on}^{TN}-c_{off}q_{off}^{TN}-\frac{1}{2}k_T(e_T^{TN})^2$	$q^{C}(p^{C}-w^{C})-c_{on}q_{on}^{C}-c_{off}q_{off}^{C}-\frac{1}{2}k_T(e_T^{C})^2$
Π_{SC}	$(p^{TN}-c)q^{TN}-c_{on}q_{on}^{TN}-c_{off}q_{off}^{TN}-\frac{1}{2}[k_1(e_1^{TN})^2+k_2(e_2^{TN})^2+k_T(e_T^{TN})^2]$	$(p^{C}-c)q^{C}-c_{on}q_{on}^{C}-c_{off}q_{off}^{C}-\frac{1}{2}[k_1(e_1^{C})^2+k_2(e_2^{C})^2+k_T(e_T^{C})^2]$

Table 4. The optimal solutions/outcomes in TSs-TA Nash and Coordination decision model

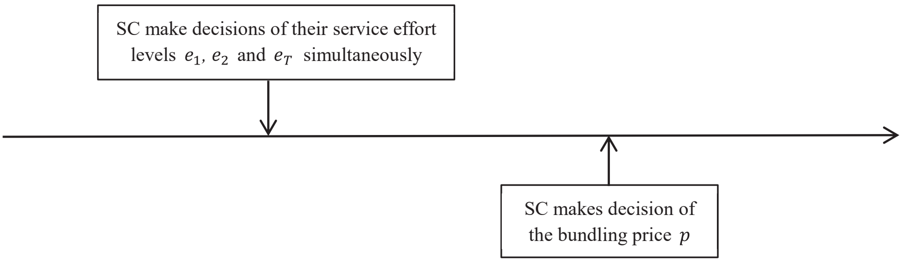


Figure 7. The diagram of decision sequence in centralized decision model

obtain the profit Π_i^c, TA will obtain the profit Π_T^c, then the profit of marine tourism omnichannel is $\Pi_1^c+\Pi_2^c+\Pi_T^c$. Among them,

$$\Pi_1^c=(\varphi p_1+w_1-c_1)q-\frac{1}{2}k_1e_1^2 \tag{8}$$

$$\Pi_2^c=(\varphi p_2+w_2-c_2)q-\frac{1}{2}k_2e_2^2 \tag{9}$$

$$\Pi_T^c = q[(1-\varphi)p - w] - c_{on}q_{on} - c_{off}q_{off} - \frac{1}{2}k_T e_T^2 \tag{10}$$

The decision sequence of a coordination decision model based on a revenue-sharing contract is shown in Figure 8. First, marine tourism omnichannel decides wholesale prices. Then, service effort levels are set simultaneously. Finally, marine tourism omnichannel decides the bundling price of the tourism package.

Feasible domain of φ^R is derived from solving $\Pi_1^R(\varphi) \geq max\{\Pi_1^{SS}, \Pi_1^{SA}, \Pi_1^{AS}, \Pi_1^{AA}, \Pi_1^{TN}\}$, $\Pi_2^R(\varphi) \geq max\{\Pi_2^{SS}, \Pi_2^{SA}, \Pi_2^{AS}, \Pi_2^{AA}, \Pi_2^{TN}\}$, $\Pi_T^R(\varphi) \geq max\{\Pi_T^{SS}, \Pi_T^{SA}, \Pi_T^{AS}, \Pi_T^{AA}, \Pi_T^{TN}\}$

$$s.t.\begin{cases} w_1^R(\varphi)\ and\ w_2^R(\varphi)\ are\ derived\ from\ solving\ the\ following\ problem \\ s.t.\begin{cases} \begin{cases} e_1^R = e_1^C \\ e_2^R = e_2^C \\ e_T^R = e_T^C \end{cases} \\ s.t.\begin{cases} \begin{cases} e_1^R\ is\ derived\ from\ solving\ \max\limits_{e_1}\Pi_1^c \\ e_2^R\ is\ derived\ from\ solving\ \max\limits_{e_2}\Pi_2^c \\ e_T^R\ is\ derived\ from\ solving\ \max\limits_{e_T}\Pi_T^c \end{cases} \\ s.t.\begin{cases} p^R(w_1,w_2) = p^C \\ s.t.\ p^R(w_1,w_2)\ is\ derived\ from\ solving\ \max\limits_{p}\Pi_T^c \end{cases} \end{cases} \end{cases} \end{cases}$$

Accordingly, we can obtain the equilibrium wholesale prices w_1^R and w_2^R, the equilibrium TSs' and TAs' service effort levels e_1^R, e_2^R and e_T^R, the equilibrium bundling price p^R and the equilibrium demand online and offline q_{on}^R and q_{off}^R; on this basis, we can obtain the equilibrium profits of TS1, TS2 and TA and marine tourism omnichannel Π_1^R, Π_2^R, Π_T^R and Π_{SC}^R (Table 4).

5. Numerical and sensitivity analyses

5.1 Numerical analysis

A "Scenic + Hotel" bundled tour package based on marine tourism product – Hong Kong DisneySea is developed for the numerical and sensitivity analyses (Disney Financial

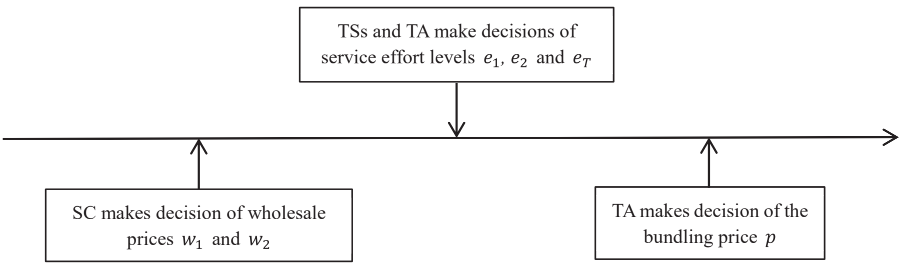


Figure 8.
The diagram of decision sequence in centralized decision model (*R*)

statement, 2017, 2018, 2019). The marine tourism omnichannel is composed of a TA (Trip.com Group) and two complementary TSs: a scenic supplier (Hong Kong DisneySea) is marked as TS1, and a hotel supplier (Disney theme park hotel) is marked as TS2. Subscripts "1" and "2" represent Hong Kong DisneySea tickets and Disney theme park hotel, respectively. Besides, we find that the online operation cost is more than that for offline from business reports because of the high customer acquisition cost. Therefore, a selected set of parameters is set as follows: $\lambda = 0.53$; $\varphi = 0.6$ $(0.575 \leq \varphi \leq 0.750)$; $a = 10{,}000$; $b = 12$; $d = 6.5$; $g = 5$; $c_1 = 50$; $c_2 = 65$; $c_{on} = 20$; $c_{off} = 15$; $k_1 = 4{,}500$; $k_2 = 4{,}200$; $k_T = 4{,}000$. With these input data, we solve and obtain the optimal pricing and service effort strategies under different decision scenarios as presented in Table 5.

According to the results from the numerical examples in Table 5, we set model *TN* (Nash decision model) as the benchmark and compare other models with it. The service effort level, demand, price, profit of each member in marine tourism omnichannel and the overall profit are optimal in model *C*. In model *TN*, the decision variables, the profits of each member and the overall profit of marine tourism omnichannel are suboptimal. In decentralized scenarios, the service effort level of TA is higher than that of TSs in other models except for *SA*. When TSs act as leader, they can obtain more profits than TA. Otherwise, TA achieves higher profit in marine tourism omnichannel. The specific analyses are as follows.

(1) *SS* VS *TN*

In *SS*, TSs' service effort levels are lower than those in *TN*. This is due to the "first-mover advantage" that the decision-maker who makes decisions firstly usually enjoys more advantages. Therefore, compared with *TN*, TSs invest less services and tend to set higher wholesale prices to obtain more profits.

As the secondary decision-maker, TA decides its service effort level and bundling price after TSs decides their service effort levels and wholesale prices. TA is forced to raise the bundling price to expand the profit margin due to higher wholesale prices. Thus, TA strives to improve its service effort level to make high-priced products more acceptable to customers.

The demand volumes are smaller than those in *TN* because of the lower service effort level of each side and the higher bundling price. Therefore, TSs and TA achieve fewer profits, and the overall profit of marine tourism omnichannel in *SS* is lower than that in *TN*. Besides, TSs can obtain more profits due to the first-mover advantage.

(2) *SA* VS *TN*

In *SA*, the service efforts invested by TSs are fewer than those in *TN* because of TSs' dominant position. Different from *SS*, TA decides its service effort level before TSs decide wholesale prices. When wholesale prices are high, TAs' profit space will be really narrow if much service effort are invested. Therefore, TA prefers less input of service efforts than in *TN*.

Similar to *SS*, the leader TSs own more competitive advantages than TA. In order to maximize the interests, TSs tend to charge TA higher wholesale prices. So, TSs get the most profits, and the profit of TA is far lower than that of TSs.

The overall profit in marine tourism omnichannel and the distribution of each member are the same as *SS*. Besides, TSs have the chance to obtain more profits due to the priority in decision-making.

(3) *AS* VS *TN*

Unusually, TA invests more service than TSs in *AS*, in which TA plays the dominant role in the market. TA believes that more service effort input may be more conducive to the increase in demand than TSs, although TA is able to slightly input fewer than TSs due to the "first

Table 5.
The optimal decisions under different scenarios

	e_1^*	e_2^*	e_T^*	q_{on}^*	q_{off}^*	w_1^*	w_2^*	p^*	π_{S1}^*	π_{S2}^*	π_T^*	π^*
SS	0.19	0.21	0.25	1012.84	412.84	308.98	323.98	780.08	369147.14	369141.21	183150.42	921438.78
SA	0.19	0.21	0.11	1012.30	412.30	309.02	324.02	780.04	368910.49	368904.58	182973.38	920788.45
AS	4.04E−04	4.33E−04	0.32	1012.15	412.15	179.48	194.48	779.90	184418.60	184418.60	551546.22	920383.42
AA	1.12E−05	1.20E−05	0.32	1012.14	412.14	179.48	194.48	779.90	184418.25	184418.25	551545.17	920381.66
TN	0.22	0.23	0.24	1368.68	768.68	244.30	259.30	715.41	415192.03	415184.54	413678.93	1244055.50
C	0.87	0.93	0.97	2442.54	1842.54	15.43	20.07	522.05	433775.28	564293.27	664310.60	1662379.15

mover advantage." Thus, in order to attract more customers, TA is willing to invest more effort. At this time, the bundling price is naturally raised.

Obviously, no matter how hard TSs try, TA occupies great advantages in *AS*. TSs are less competitive and their service efforts have less influence on the performance of marine tourism omnichannel. Therefore, TSs input fewer service efforts than in *TN*. Correspondingly, the wholesale prices are lower than those in *TN*.

We can easily find that the extremely low service effort levels of TSs together with the high price lead to lower demands than *TN*. The profits of marine tourism omnichannel and its members are smaller than those in *TN*. Moreover, TA acting as the leader obtains more profit than TSs who act as followers.

(4) *AA* VS *TN*

TA invests more service efforts than TSs. The reason is similar to that in *AS*.

In *AA*, TSs' decisions on service effort levels precede TA's decision on pricing. TAs' profit margin will decrease if TSs set higher wholesale prices. To avoid TA seeking for other cheaper TSs, TSs tend to offer lower wholesale prices. It is obvious that TA has absolute advantages in this situation. Therefore, TSs tend to input lower service effort levels to achieve economic profitability.

The overall profit in marine tourism omnichannel and its distribution are the same as those in *AS*. Moreover, TA who acts as the leader obtains more profit than TSs who are the followers.

(5) *C* VS others

The service effort levels, bundling price, wholesale prices, profits of marine tourism omnichannel and each member are optimal under the revenue-sharing contract coordination mechanism. TSs and TA provide the highest service effort level and the bundling price is much lower, so the demand for marine tourist products in omnichannel is far higher than those in other conditions. Besides, TSs are still profitable although TSs sell products to TA at wholesale prices below costs. This is because of the high proportion of transfer payments shared by TA.

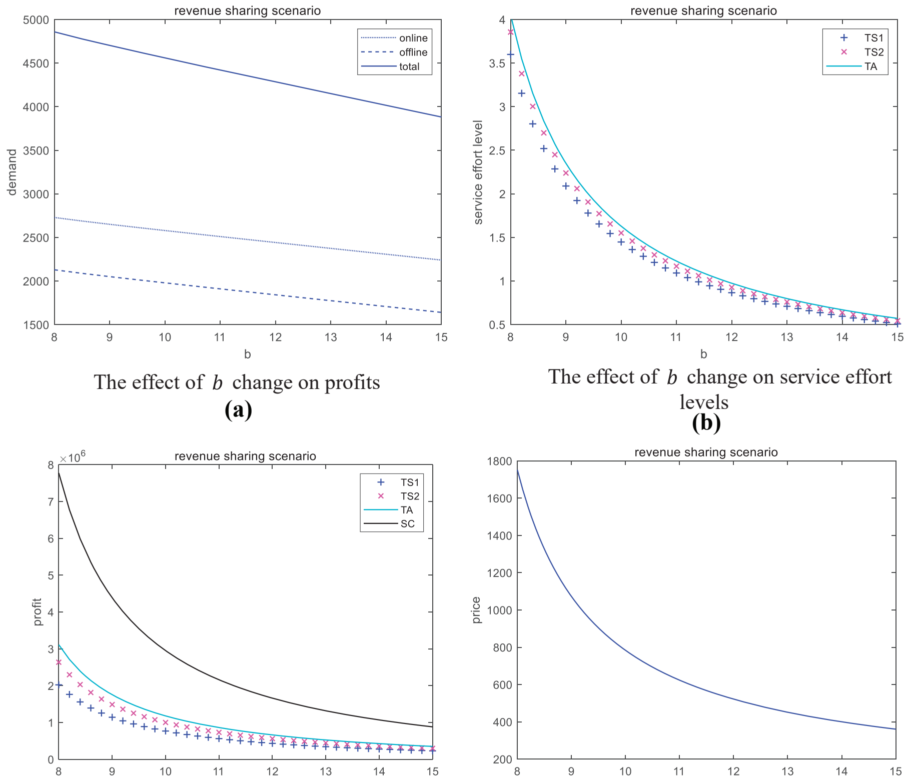
5.2 Sensitivity analysis

5.2.1 The effect of price elasticity coefficient change. In this section, we conduct numerical studies to illustrate the effects of price elasticity coefficient b. We let b vary over [8, 15] with the step length of 0.05. Figure 9 depicts these results.

As is shown in Figure 9, coefficient b is inversely proportional to the bundling price, demand, service effort level and profits. For both online and offline channels, the profits of TSs, TA and marine tourism omnichannel will gradually decrease as the price elasticity coefficient b increases. In addition, with the increase in price elasticity coefficient, the range of change gradually decreases and tends to be consistent. This is because when b increases, customers will be more sensitive to the price in the present channel. The price change will be a bigger impact on consumers' purchase decisions. Therefore, the decision-makers tend to take a more conservative strategy, such as to lower the service level or the bundling price. However, this often leads to the members in the supply chain cannot get the ideal profits.

5.2.2 The effect of inter-channel fusion coefficient change. Now we investigate the impact of inter-channel fusion coefficient d on the price, demands, profits of marine tourism omnichannel and each member. We vary d from 0 to 10 with a step length of 0.1.

Figure 10 shows that d is directly proportional to bundling price, demand, service effort levels and profits. The increase of d means the enhancement of mutual promotion ability



The effect of b change on profits
(a)

The effect of b change on service effort levels
(b)

The effect of b change on demands
(c)

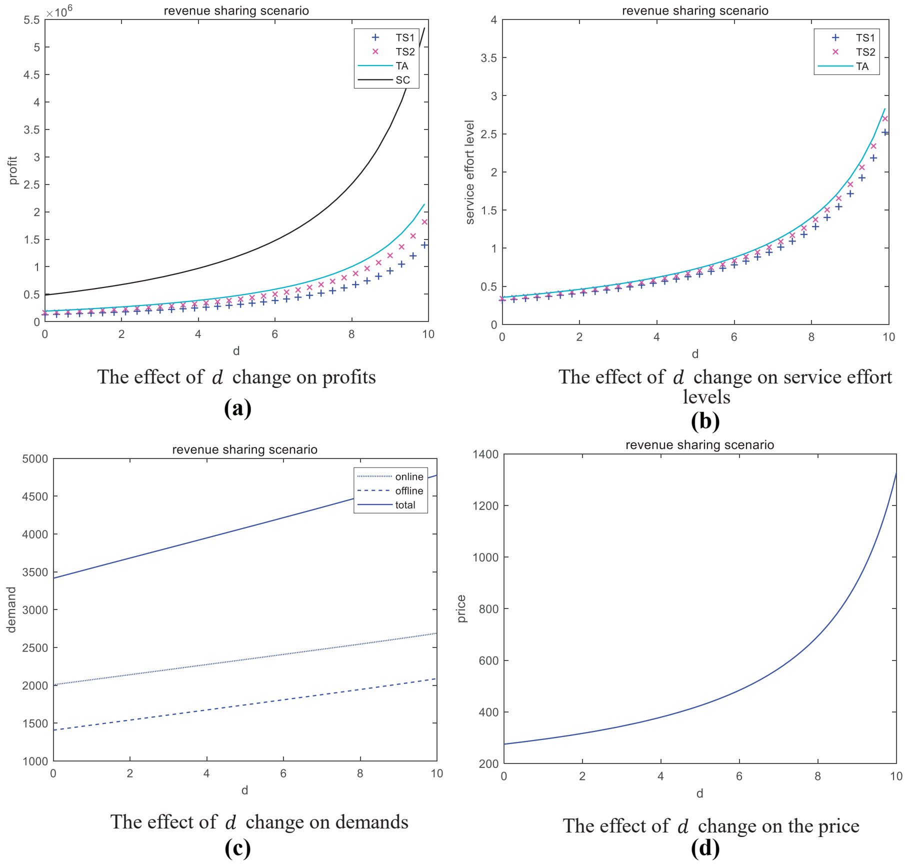
The effect of b change on the price
(d)

Figure 9.
The effect of price elasticity coefficient b change

between channels. Obtaining the information on marine tourism products online, tourists tend to go to brick-and-mortar stores to acquire more details about tourism products. Thoughtful offline services will enhance their experience satisfaction, thus increasing the demand for offline channels. On the contrary, due to the convenience of products' information details or other reasons, tourists who experience marine tourism products from offline physical stores will more willing to choose the online channel. A good operation of either online or offline channels will bring more benefits to the other channel and omnichannel performance, so TA and TSs may try their best to improve service effort levels to attract more customers. Thus, the service effort cost increases, and the bundling price accordingly rises.

5.2.3 The effect of service effort coefficient change. Now we investigate the impact of service effort coefficient g on the prices, demands, and profits of marine tourism omnichannel and its members. We let g vary over [0, 30] with the step length of 0.1. Figure 11 depicts these results.

It is clearly presented that g is directly proportional to the price of tourism products, demand, service effort levels and profits. With the increase of service effort coefficient g are more sensitive to the change of service effort level, that is, a small change in service effort



The effect of d change on profits
(a)

The effect of d change on service effort levels
(b)

The effect of d change on demands
(c)

The effect of d change on the price
(d)

Figure 10.
The effect of inter-channel fusion coefficient d change

level will have a greater impact on consumer demand. So, TSs and TA will be willing to improve service effort levels to attract more potential customers. When TA inputs more service efforts, the operating cost increases accordingly. Then, TA will raise the price of marine tourism products to expand profit margins. The more profit TA generates, the more it shares with TSs by revenue-sharing contract. Therefore, the profits of marine tourism omnichannel and each member will increase as well.

5.2.4 The effect of service effort levels change. Now we investigate the impact of service effort levels of TSs and TA e_1, e_2 and e_T on the bundling price and profits in marine tourism omnichannel. We let e_1, e_2 and e_T vary over [0, 10] with a step length of 0.3.

As is shown in Figure 12(a–c), the bundling price of tourism product increases along with the promotion of e_1, e_2 and e_T. For TSs, the improvement of service effort level leads to an increase in service effort cost, which causes an increase in TSs' wholesale prices. The same as TA. Thus, TA will raise the bundling price to achieve economic profitability. The higher the level of service, the higher the service effort cost, and the higher the bundling price of TA.

As is shown in Figure 12(d–f), the increase of e_1 (e_2/e_T) will lead to the increase of profit of TS1 (TS2/TA) but has little effect on the other two entities. This is because the improvement

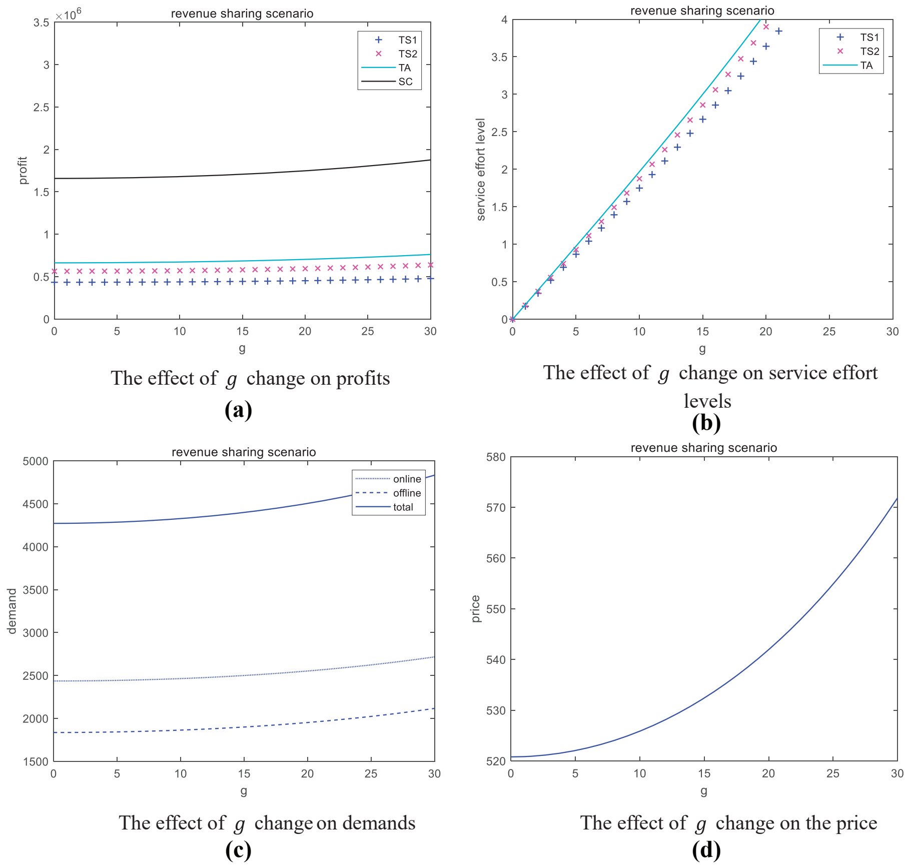


Figure 11.
The effect of service effort coefficient g change

of service effort level leads to the increase of service cost and the decrease of profit space, respectively, but it has nearly no influence on the other two members.

6. Managerial insights

According to the findings from the models and numerical analysis presented in this paper, we get some insights for managers in the marine tourism industry.

First, bundling price is directly proportional to service effort coefficient and inversely proportional to the price elasticity coefficient. TAs can bundle products of different grades according to consumption ability. For customers with strong consumption ability, high-end tourism products can be bundled with a higher price to create a larger profit space. On the contrary, TAs should customize mid-end complementary products with high-cost performance to create more demand. In addition, a mix product package with different levels of products can also be considered. For example, Trip.com Group provides a bundle portfolio consisting of surfing or diving and Jinjiang Hotel which is a budget hotel. This product package meets the needs of travelers who do not have rigid accommodation requirements but want to enjoy high-end exciting projects.

Second, the improvement of the service effort coefficient can promote service effort levels of TSs and TA as well as demands in the marine tourism omnichannel. Therefore, tourist

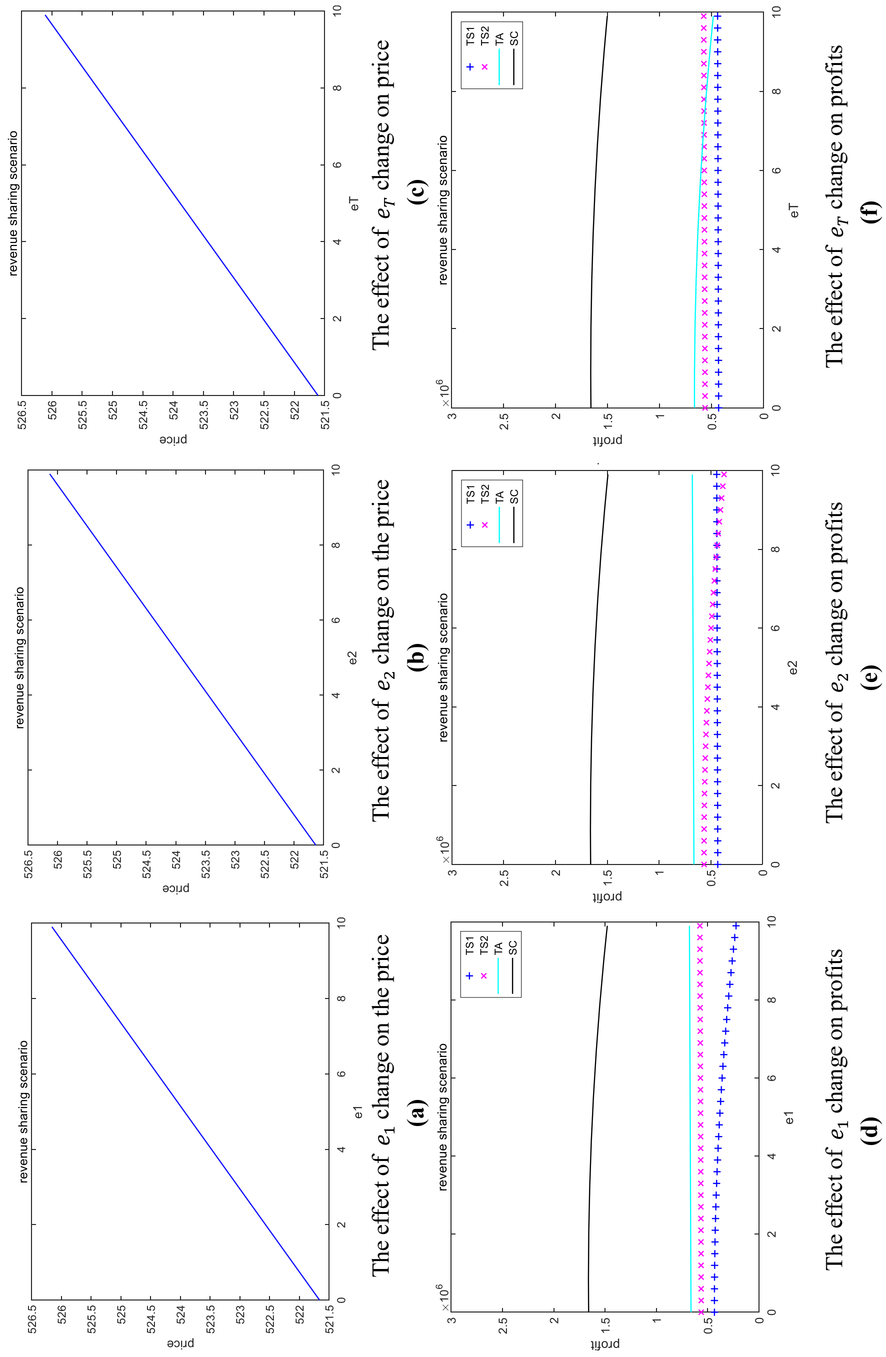


Figure 12.
The effect of service effort levels e_1, e_2 and e_T change

enterprises should constantly strengthen infrastructure construction and devote themselves to improving service levels to attract more tourists. For example, some scenic spots have adopted blockchain technology and guide tourists to plan their tour routes by using game-based sightseeing methods. Thus, the interaction between scenic spots and tourists can be enhanced, and their experience satisfaction will be improved. As for TAs, advisory information about products should be given more quickly and product pages need to be optimized. Showrooms in physical stores can be considered for tourists to experience the scene of their favorite destinations.

Third, the increase of the inter-channel fusion coefficient contributes to the promotion of service effort levels of TSs and TA, demand and performance of marine tourism omnichannel. It is suggested to use big data or cloud computing technology to combine the information acquisition of online channels with the perception experience of offline channels. By analyzing user data such as evaluation and scoring, customers' demands and behaviors can be timely predicted, and response can be made rapidly to them.

Finally, with contract coordination, the service effort level, the volumes of demand and profits are more optimal than those in other situations. Therefore, TS and TA should consider the overall situation and the cooperation between the two sides should proceed from the long-term interests to jointly maintain a good relationship. Benefit reciprocity mechanisms are available to achieve a win-win situation. In this way, not only tourism enterprises can obtain optimal profits, but also customers have chance to enjoy the best service and price.

7. Conclusions

With the growing economic impact of e-commerce and the increasing trend of omnichannel mode, more considerate services can be provided to customers by integrating purchasing data and pre-sale scene experience. However, knowledge is scarce about pricing decisions of complementary products in marine tourism omnichannel and most literature only studied the service provided by TS or TA unilaterally. This paper studies the bundling pricing strategy and coordination mechanism between two TSs and a TA who distributes complementary marine tourism products in an omnichannel considering the joint efforts of both sides and enriches the research results in the aspect of service in marine tourism omnichannel.

According to the results, we draw some conclusions as follows. First, the bundling price is directly proportional to the inter-channel integration coefficient and service effort coefficient, and inversely proportional to the price elasticity coefficient. Second, due to TAs' absolute advantages and the less influence of TSs' service effort levels on the performance of marine tourism omnichannel, TA tends to provide a higher service effort level than TSs when TA plays the dominant role. Third, regardless of the dominant position of TSs or TA, the profits of marine tourism omnichannel and each member under the alternating decision models are more than those in sequential decision models. Fourth, unduly improving the service effort level will not increase the profit of TSs or TA but will lead to a decline in profit due to the increase in cost and the decrease in market demand. Fifth, the marine tourism omnichannel can obtain the optimal profit when TSs and TA set the service effort levels or prices simultaneously. Finally, by adopting a contract coordination mechanism of revenue sharing, TSs and TA can achieve a win-win situation.

However, this paper also has some areas to improve on in the future. First, we assume the customer demand is a linear function with certain parameters, while in the real world, the market environment may be complex and diverse. Therefore, uncertainty in demand can be considered in future research. Besides, consumers may have different consumption preferences, so future studies will focus on the impact of consumer heterogeneity on bundling pricing decisions. In addition, there may be more suppliers providing tourist products to TA in bundle sales. Multiple tourist suppliers can be taken into consideration as a potential research direction in the future.

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