

# Revenue-sharing Contract Coordination in the Tourism Service Supply Chain based on Fairness Concerns

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## Abstract

The paper introduce the behaviour of fairness concerns into the tourism service supply chain system, and study the influence of tour organizing agency's fairness concern to the effectiveness of tour organizing agency, the revenue of local travel agency and the whole supply chain's effectiveness, and used the revenue sharing contract to coordinate supply chain, and get the feasible interval and feasible interval length of the income share factor. The research show that the revenue sharing contract could coordinate the whole supply chain system and improve the effectiveness of the tour organizing agency, the local travel agency and the whole supply chain. The degree of improvement is decided by the fairness concern degree. The feasible interval length of revenue sharing factor would get shorter by the increase of fairness concern degree. Finally, the examples are presented to validate the conclusion.

*Keywords:* Fairness Concerns; the Tourism Service Supply Chain; Tour Organizing Agency; Local Travel Agency; Revenue-sharing Contract

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## 1 Introduction

Tourism service supply chain is to combine all kinds of tourism service resources to integrate and coordinate various tourism service suppliers (including the services of dining, boarding, tripping, travelling, shopping, entertainment and etc.) for the co-operation of customer value. However, in the tourism supply chain, the service suppliers all are independent subjects of interests, they peruse the maximizing profit separately and have interest conflict each other, these problems influence the whole service effectiveness of it. As the members of the tourism service supply chain, tour organizing agency and local travel agency should know how to coordinate their relationship of cooperation and competition to increase the whole chain's performance and the interest's subject's effectiveness. Guo (2008) has proved that the whole tourism supply chain's effectiveness will be enhanced after their integration [1]. Zhang Xiaoming and Zhang Hui applied the Stackelberg model and Classical newsboy model to make a discussion in terms of the coordination in the tourism service chain [2]. Yang Li and Li Bangyi (2009) applied the Stackelberg model to investigate the pricing strategies and profit of tour organizing agency and local organizing agency under the condition of decentralized pricing and alliance pricing [3]. Pan Hanzeng (2011) abstracted the travel service chain as the client based on the travel agency and the agent based on dining-boarding-tripping enterprise, and established the tourism supply chain decision-making model based on the principal-agent relationship, and verified option contract's effectiveness in the case of coordinating tourism supply chain [4]. Li Jun (2014) used Steinberg's Stackelberg

model to analyze price tragedy and mutual relationship of the theme park and tourism agency, eventually came up with the coordinate scheme that can achieve the whole system's optimality, and allocated the mutual profit by adopting the Nash's bargaining model of equilibrium theory.

In the studies of traditional supply chain, decision-makers were definitely rational, and all were intended to maximize their self-interest. However, according to the behavioural studies, people found that we were more concerned about fairness, which meant the fairness concerns. Nowadays, the study about fairness concerns mainly focus on creating supply chain. Cui (2007) and other co-operators introduced fairness concerns into newsboy model in the environment of certain market demand, and studied the fairness concerns influence on supply chain contract [6]. Du Shaofu and his cooperators (2010) considered about the retailers fairness concerns based on the newsboy model, and found that wholesale price contract was uncoordinated with supply train when retailers took fairness concerns into consideration, but the buy-back contract was still coordinate with revenue-sharing contract without changing their compatibility condition [7]. Tan Jiayin and other co-operators (2012) discussed about the influence of retailer's fairness concerns behaviour on the revenue-sharing contract's coordinated effectiveness [8]. Chen Zhaobo (2013) introduced the retailers fairness concerns to a supply chain system which are made up of one manufacturer and two retailers, and studied the fairness concerns coefficient's influences on retailer's equilibrium decision, equilibrium profit, equilibrium value under the contract of wholesale price [9].

The recent study shows that the documents for quantitative and coordination research are lesser. Setting in fairness concerns, this essay study the interrelation

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between tour organizing agency and local travel agency in tourism service supply chain and coordinate the contract. The essay discuss the impact of fairness concerns on the whole effectiveness of tourism service supply chain and individual benefits of travel agency, and analyze the validity of revenue-sharing contract's coordination function to tourism service supply chain. At the same time, it discusses the influence of fairness concerns on the validity of revenue-sharing contract as well.

**2 Model description and fundamental hypothesis**

Provided that the travel supply chain is consisted of a local travel agency, a tour organizing agency and tourists. On one hand, the local travel agency of tourism destination starts to develop tourism products according to the market demands (or the commission of a tour organizing agency). Then taking the unit variable cost  $c_d$  into account, mainly including the tourism product cost into account, mainly including the tourism product cost, reception cost and decision quote to maximize own profits  $\Pi_d$ ,  $w$  is the decision variable of a local travel agency. On the other hand, the tour organizing agency determines the corresponding group price  $P$ , on the basis of the quote  $c_z$  of a local travel agency and the unit variable cost  $c_z$ , mainly operating cost. It maximizes the profits  $\Pi_z$ ,  $P$  is the decision variable of a tour organizing agency. The local travel agency arranges touring activities to meet the needs of tourists, who are members of tourist groups, designed by the tour organizing agency. In general,  $w + c_z \leq P$ . The hypothetical information of this article is completely symmetric. The tour organizing agency and local travel agency aim at maximizing respective profits on the grounds that they are clear about the others cost and pricing.

Assuming a basic demand to be  $a$ , the market demand  $q$  varies with the corresponding group price  $P$ . They are in inverse proportion, when  $P$  decreases,  $q$  increases. Assuming the sensitive extent that the market demand react to the corresponding group price to be  $b$ , and when  $a$  and  $b$  are positive, the demanding function of a tour organizing agency is

$$q = a - bp \tag{1}$$

From the above assumptions, the profits of a tour organizing agency and a local travel agency are respectively,

$$\Pi_z = (p - w - c_z)q = (p - w - c_z)(a - bp) \tag{2}$$

$$\Pi_d = (w - c_d)q = (w - c_d)(a - bp) \tag{3}$$

**3 The balanced decision under the tour organizing agency's fairness concerns**

When considering the tour organizing agency's fairness concerns, we should analyze the game relationship between the tour organizing agency and local travel agency as well as the influence on travel agency and the tourism service supply chain by fairness concerns. The tour organizing agency purchases tourism item units from local

travel agency according to their quoted price and gives the item's quoted price. Supposing there are fairness concerns in tour organizing agency, therefore, tour organizing agency could compare its local profits with local travel agency's profit to express the concerns of fairness. So the Utility Function of Fairness concerns in the tour organizing agency are:

$$U_z = \Pi_z - \lambda (\Pi_d - \Pi_z) = (1 + \lambda)\Pi_z - \lambda \Pi_d \tag{4}$$

$$= (1 + \lambda)(p - w - c_z)(a - bp) - \lambda(w - c_d)(a - bp)$$

In this function,  $U_z$  represents the utility of tour organizing agency,  $\lambda (\lambda > 0)$  represents coefficient of Fairness concerns, it represents the utility's deviation. When  $\lambda = 0$ , the agency's utility will be decreasing with  $\Delta$  increasing, when  $\lambda = 0$ , the agency is fair and neutral.  $\Delta = \Pi_d - \Pi_z$ , its utility isn't related to  $\Delta$ .

Supposing the local travel agency is the leading party while the tour organizing agency is the following party. Then, the deciding sequence is as follows. Firstly, the tour organizing agency decides quoted price according to tourism item units. Secondly, the tour organizing agency decides its own quoted price according to the local travel agency. Then two parties will form a game relationship called "Stackelberg". We could obtain the result by backward induction.

Put (4) into  $p$  and get the first derivative:

$$\partial U_z / \partial p = (1 + \lambda)(a - 2bp + bw + bc_z) + \lambda b(w - c_d) \tag{5}$$

Make  $\partial U_z / \partial p = 0$ , the tour organizing agency's quoted price is:

$$p = \frac{(1 + \lambda)a + (1 + 2\lambda)bw + (1 + \lambda)bc_z - \lambda bc_d}{2b(1 + \lambda)} \tag{6}$$

The local travel agency's utility function is still not changing. It is (3), therefore, we could put (6) into (3) and the local travel agency's profit function is:

$$\Pi_d = (w - c_d)[a(1 + \lambda) - (1 + 2\lambda)bw - (1 + \lambda)bc_z + \lambda bc_d] / 2(1 + \lambda) \tag{7}$$

Put (7) into  $w$  and get the first derivative:

$$\partial \Pi_d / \partial w = a(1 + \lambda) - 2(1 + 2\lambda)bw - (1 + \lambda)bc_z + \lambda bc_d + (1 + 2\lambda)bc_d \tag{8}$$

Make  $\partial \Pi_d / \partial w = 0$ , then the local travel agency's best quoted price is:

$$w^* = \frac{(1 + \lambda)(a - bc_z) + (1 + 3\lambda)bc_d}{2b(1 + 2\lambda)} \tag{9}$$

Put (9) into (6), then the tour organizing agency's best quoted price is:

$$p^* = \frac{3a + bc_z + bc_d}{4b} \tag{10}$$

Put (10) into (1) then the marketing demand is:

$$q^* = \frac{a - bc_z - bc_d}{4} \tag{11}$$

Put (9), (10), (11) into (4) and (3) respectively, then the tour organizing agency's utility and the local travel agency's profit are:

$$U_z^* = \frac{(1 + \lambda)(a - bc_z - bc_d)^2}{16b} \tag{12}$$

$$\Pi_d^* = \frac{(1 + \lambda)(a - bc_z - bc_d)^2}{8b(1 + 2\lambda)} \quad (13)$$

According to (12) and (13), the tourism service supply chain's total utility is:

$$\Pi_s^* = U_z^* + \Pi_d^* = \frac{(3 + 2\lambda)(1 + \lambda)(a - bc_z - bc_d)^2}{16b(1 + 2\lambda)} \quad (14)$$

Conclusion 1: under the tour organizing agency's Fairness concerns, the tour organizing agency's quoted price and its marketing demand aren't related to Fairness concerns' degree.

Prove: according to (10) and (11),

$$p^* = \frac{3a + bc_z + bc_d}{4b}, \quad q^* = \frac{a - bc_z - bc_d}{4}$$

we can find they are not related to  $\lambda$  (the Fairness concerns' coefficient).

Conclusion 2: the local travel agency's quoted price would be decreasing with tour organizing agency's Fairness concerns' degree increasing.

Prove by:  $\partial w^* / \partial \lambda = -\frac{2b[a - b(c_z + c_d)]}{4b^2(1 + 2\lambda)^2}$ .

$\lambda > 0, a > 0, b > 0, q = a - bp > 0, p > c_z + c_d,$  so  $\Delta w < 0, \partial w^* / \partial \lambda < 0$ .

Conclusion 3: the tour organizing agency's profit would be increasing with it's Fairness concerns' degree increasing, while the local travel agency's profit will be decreasing with the tour organizing agency's Fairness concerns' degree increasing

Prove by (12), (13):  $\partial U_z^* / \partial \lambda = \frac{(a - bc_z - bc_d)^2}{16b}$ ,

$$\partial \Pi_{d2} / \partial \lambda = -\frac{(a - bc_z - bc_d)^2}{8b(1 + 2\lambda)^2(1 + 2\lambda)^2},$$

because  $\lambda > 0, a > 0, b > 0,$  so  $\Delta U_z > 0,$  then  $\Delta \Pi_d < 0, \partial U_z / \partial \lambda > 0, \partial \Pi_{d2} / \partial \lambda < 0$ .

#### 4 The coordination under the contract of revenue-sharing

##### 4.1 TRAVEL SUPPLY CHAIN'S CENTRALIZED DECISION-MAKING SITUATION

In order to compare with the decentralize decision-making based on tour organizing agency, it is needed firstly to analyze the service supply chain's centralized decision-making situation, which takes supply system as a whole, so it neglects the influence of fairness concerns. What the supply chain system need to be sure is the decision variable, including tour organizing agency's quoted price  $P$  to the travelers and decision-making problem in supply chain system  $\Pi_s$ , which means the maximum profit of supply chain system. Supposed that the whole tourism service supply chain's profit is  $\Pi_s$ , then:

$$\Pi_s = (p - c_z - c_d)q = (p - c_z - c_d)(a - bp) \quad (15)$$

Formula (15) derivation of  $P$ , that is  $\partial \Pi_s / \partial p$ , and then make  $\partial \Pi_s / \partial p = 0$ , come out the tour organizing

agency's optimized quotation price  $p^{**}$  based on the centralized decision-making:

$$p^{**} = \frac{a + bc_z + bc_d}{2b} \quad (16)$$

Put (16) into (1) and (15), the profit of optimal market demand and supply chain system is:

$$q^{**} = \frac{a - bc_z - bc_d}{2} \quad (17)$$

$$\Pi_s^{**} = \frac{(a - bc_z - bc_d)^2}{4b} \quad (18)$$

##### 4.2 COORDINATION BASED ON REVENUE-SHARING CONTRACT

Because both tour organizing agency and local travel agency proceed from their own benefits under the occasion of decentralized decision, the whole supply chain cannot maximize profits. The following discussion is about the validity of coordinating the tourism services supply chain by revenue-sharing contract which is marked by parameter  $(w_\phi, \phi)$ . Assuming  $w_\phi$  as the local travel agency's quote under revenue-sharing contract;  $\phi$  as sales revenue share tour organizing agency retains, thus  $(1 - \phi)$  is a share gained from sales revenue of tour organizing agency by local travel agency, and then the profit function of tour organizing agency and local travel agency are:

$$\Pi_z = (\phi p - w_\phi - c_z)q = (\phi p - w_\phi - c_z)(a - bp) \quad (19)$$

$$\Pi_d = (1 - \phi)pq + (w_\phi - c_d)q = [(1 - \phi)p + w_\phi - c_d](a - bp) \quad (20)$$

For fairness concerns of tour organizing agency, assuming fairness concerns coefficient is  $\lambda$ , therefore the utility function of tour organizing agency is:

$$U_z = \Pi_z - \lambda(\Pi_d - \Pi_z) = (1 + \lambda)\Pi_z - \lambda\Pi_d = (1 + \lambda)(\phi p - w_\phi - c_z)(a - bp) - \lambda[(1 - \phi)p + w_\phi - c_d](a - bp) \quad (21)$$

Formula (21) derivation of  $P$  is:

$$\partial U_z / \partial p = (\phi + 2\lambda\phi - \lambda)a + 2(\lambda - \phi - 2\lambda\phi)bp + (1 + 2\lambda)bw_\phi + (1 + \lambda)bc_z - \lambda bc_d \quad (22)$$

Then the tour organizing agency quotation is:

$$P = \frac{(2\lambda\phi + \phi - \lambda)a + (1 + 2\lambda)bw_\phi + (1 + \lambda)bc_z - \lambda bc_d}{2b(2\lambda\phi + \phi - \lambda)} \quad (23)$$

According to the analyzed result through centralized decision, when the tour organizing agency's quotation  $P$  is equal to the quotation  $P$  under the occasion of centralized decision, the supply chain can gain maximum profit. Making formula (16) equal to formula (23), then:

$$\frac{(2\lambda\phi + \phi - \lambda)a + (1 + 2\lambda)bw_\phi + (1 + \lambda)bc_z - \lambda bc_d}{2b(2\lambda\phi + \phi - \lambda)} = \frac{a + bc_z + bc_d}{2b} \quad (24)$$

The operator quotation can be gained based on revenue-sharing contract in consistent with formula (24):

$$w_\phi = (\phi - 1)c_z + \phi c_d \quad (25)$$

Substitute (16), (25) into (20) and (21), tour organizing agency's effectiveness and the operator's profit are:

$$\Pi_d^{****} = \frac{(1 - \phi)(a - bc_z - bc_d)^2}{4b} \quad (26)$$

$$U_z^{****} = (2\phi\lambda + \phi - \lambda) \frac{(a - bc_z - bc_d)^2}{4b} \quad (27)$$

According to formula (12), (13), (26) and (27), the effectiveness difference between tour organizing agency and local travel agency under the condition of whether implementing revenue-sharing contract or not and the fairness concerns of tour organizing agency is:

$$\Delta\Pi_d = \Pi_d^{***} - \Pi_d^{**} = \frac{[2(2\lambda+1)(1-\phi) - (1+\lambda)](a - bc_z - bc_d)^2}{8b(1+2\lambda)} \quad (28)$$

$$\Delta U_z = U_z^{***} - U_z^{**} = \frac{[2(2\phi\lambda + \phi - \lambda) - (1+\lambda)](a - bc_z - bc_d)^2}{16b} \quad (29)$$

The precondition of realizing the overall coordination of the supply chain by revenue-sharing contract is: both the effectiveness of tour organizing agency and the profit of local travel agency have been improved, that is  $\Delta\Pi_d \geq 0$  and  $\Delta U_z \geq 0$ . The value scope of revenue-sharing factor  $\phi$  according to formula (28) and (29) is:

$$0 \leq \phi \leq \frac{1+3\lambda}{2(1+2\lambda)} \quad (30)$$

$$\frac{1+5\lambda}{4(1+2\lambda)} \leq \phi \leq 1 \quad (31)$$

Thus, the feasible interval of revenue-sharing factor  $\phi$  is:  $[\frac{1+5\lambda}{4(1+2\lambda)}, \frac{1+3\lambda}{2(1+2\lambda)}]$ , and the length of its feasible

interval is:  $\frac{1+\lambda}{4(1+2\lambda)}$ .

Conclusion 4: the higher  $\lambda$  is, the shorter the length of feasible interval becomes. The higher the degree of tour organizing agency fairness concerns is, the smaller the coordinate spaces of revenue-sharing contract becomes.

When  $\lambda=0$ , the feasible interval of revenue-sharing factor  $\phi$  is  $[\frac{1}{4}, \frac{1}{2}]$ , its feasible interval length is  $\frac{1}{4}$ , and the length of feasible interval is maximum, that is, when there is no fairness concerns, the coordination space of revenue-sharing contract is maximum. While  $\lambda \rightarrow +\infty$ , the feasible interval of revenue-sharing factor  $\phi$  is  $[\frac{5}{8}, \frac{3}{4}]$ , its feasible interval length tends to be  $\frac{1}{8}$ , and the length of feasible interval is minimum, that is, when  $\lambda$  is quite high, and the coordination space is of revenue-sharing contract is less though, there is still implementing space, but the contract negotiation becomes more difficult.

**5 Analysis of examples**

If there is a tour organizing agency A and a local travel agency B. Some relevant parameters are set as follows:  $a = 1000, b = 10, c_z = 100, c_d = 200$ . For local travel agency belongs to fair neutrality, its effectiveness is equal to the profit so that the utility of the whole supply chain is equal to the sum of utility both of tour organizing agency and local travel agency. Since the tour organizing agency's

quotation is irrelevant with its degree of fairness concerns, thus the calculating results are:  $P = 375, p = 350$ . When  $\lambda$  changes, Table 1 can be concluded according to formulas (9),(10),(11),(12) and (13). TABLE 2 can be concluded in light with formula (25), (26), (27), (30) and (31).

TABLE 1 Effects on varieties with fairness concerns of tour organizing agency

$\lambda$ Value	Local Travel Agency Quotation $w^*$	Market Demand $q^*$	Tour Organizing Agency Effectiveness	Local Travel Agency Profit	Supply Chain Effectiveness
0	250	250	6250	12500	18750
0.1	246	250	6875	11458	18333
0.3	241	250	8125	10156	18281
0.5	238	250	9375	9375	18750
0.8	235	250	11250	8654	19904
1.2	232	250	13750	8088	21838
1.5	231	250	15625	7813	23438
5	227	250	37500	6818	44318
10	226	250	68750	6548	75298

Analysis of TABLE 1 can be:

When tour organizing agency fair is neutral ( $\lambda = 0$ ), the tour organizing agency's offer and market demand are equal under the situation of the tour organizing agency's fairness concerns, and the fairness concerns level has no effect on the tour organizing agency's offer and market demand. That is to say, the fairness concerns will not influence the customer's interest and the market demand. In the case of fairness concerns, when the local travel agency's offer is lower than the tour organizing agency's, and meanwhile the former will decrease as the later increase, which means the fairness concerns of tour organizing agency made an adverse effect on local travel agency and does a harm to its interest.

The performance of tour organizing agency on the condition of the fairness concerns of tour organizing agency is higher than the fairness neutrality of that ( $\lambda = 0$ ), and it increased with the increasing rate of the fairness concerns of tour organizing agency. While it's just the other way around between the relation of the profit of local travel agency and the fairness concerns of tour organizing agency. Those indicate that the fairness concerns of tour organizing agency is benefit for tour organizing agency itself while does harm to local travel agency. What's more, the profit of tour organizing agency is far better than that of local travel agency with the increasing rate of the fairness concerns of tour organizing agency. Therefore, when the rate of the fairness concerns of tour organizing agency is too large, because of the little profit, the local travel agency will abandon the cooperation between them.

TABLE 2 Effects on revenue-sharing contract in fairness concerns of tour organizing agency

$\lambda$ Value	$\phi$ Floor	$\phi$ Ceiling	$\phi$ Value	Tour Organizing Agency Quotation $p^{**}$
0	0.25	0.50	0.38	350
0.1	0.31	0.54	0.43	350
0.3	0.39	0.59	0.49	350
0.5	0.44	0.63	0.53	350
0.8	0.48	0.65	0.57	350
1.2	0.51	0.68	0.60	350
1.5	0.53	0.69	0.61	350
5	0.59	0.73	0.66	350

10	0.61	0.74	0.67	350
13	500	9375	15625	25000
28	500	10313	14323	24635
48	500	12188	12695	24883
59	500	14063	11719	25781
70	500	16875	10817	27692
79	500	20625	10110	30735
83	500	23438	9766	33203
98	500	56250	8523	64773
102	500	103125	8185	111310

Notes: the value of  $\Phi$  reflects the capacity of which tour organizing agency negotiates with local travel agency. In this example, it is assumed that the two sides are well-matched in price negotiation, so the value of  $\Phi$  in column four is the middle value of confidence intervals.

Analysis of table 2 can be:

Whether there are fairness concerns in tour organizing agency or not, it will not influence the supply chain's coordination state under the situation of revenue-sharing contract. Therefore, revenue-sharing contract can increase tour organizing agency's effectiveness, local travel agency's profit and the whole supply chain's performance in the background of tour organizing agency's fairness concerns.

The income share factor  $\phi$  is affected by tour organizing agency's fairness concern degree and will be larger while the greater the fairness concern degree, and the smaller of its feasible interval and negotiation interval.

## 6 Conclusions

The fairness concerns behavior is introduced into the tourism service supply chain system consisted of a tour organizing agency and a local travel agency in the article.

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