Service and revenue sharing strategies in a dual-channel supply chain with fairness concerns

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Abstract

This paper incorporates the concept of fairness in a dual-channel supply chain to examine the effect of fairness concerns on the supply chain partners' service and revenue-sharing strategies in three different scenarios: only the retailer is concerned about fairness, only the manufacturer is concerned about fairness, and both parties are concerned about fairness. Though applying the equilibrium analysis, the results show that (1) Fairness concerns strongly influence the manufacturer's and the retailer's decision-making and utility. (2) The revenue sharing ratio increases with the strengthening of channel members' fairness concerns. (3) If only the retailer is concerned about fairness, the retailer's service is unaffected by his fairness concerns. (4) There exists a Pareto improvement for channel members' utility when the manufacturer without fairness concern becomes fair-minded.

Keywords: fairness concerns, dual-channel supply chain, service level, revenue sharing

1 Introduction

With rapid development and wide use of the Internet and related information technology, more and more consumers are accustomed to shopping online, many well-known manufacturers in a variety of industries such as Apple, HP, Estee Launder, Nike, Lenovo, etc., have already redesigned their sales channel structures by engaging in direct online sale in order to meet different customer requirements that cannot be met by the bricks-and-mortar retail channel. Manufactures that adopt the online direct channel can remove the intermediary, increase the potential market demand and improve the efficiency of supply chain. It also can make high profits by directly controlling the distribution and price [1]. Meanwhile, consumers prefer hybrid channel, they can choose freely in the online direct channel and retail channel according to their preference [2]. However, a side effect of this trend is that the retailers, manufacturer's traditional retailer partners may feel disenfranchised and thus tend to resist the direct channel initiative because they perceive that the direct channel is bound to cannibalize their market shares [3, 4].

To mitigate this "channel conflict", some manufacturers use consistent pricing scheme (e.g., ZARA, Apple, etc.) by selling the products in both channels at the same price [5], and the traditional retailers continuously improve their retail service to survive, thus the service level in dual-channel is higher than it in single channel [6, 7]. Retail services have significant effects on customers' channel choice, demand and loyalty [4, 8, 9], it also strongly influences the manufacturer and the retailer's pricing strategies and profit [10-12] Therefore, retail services play a strategic role in a dual-channel supply chain, which is the research subjects of this paper. Both the manufacturer and the retailer can be always benefited no matter who provides service in the Stackelberg game [13]. Although manufacturers may provide consumers with services such as product information and consultations, graphic pictures and sound, traditional retailers play a key role in providing diverse transactional and post-sales services such as personal inspections, additional expertise, advice and technical support, as well as the easy and prompt replacement or refund for defective parts [14]. Therefore, in most cases, manufacturer free-rides retailer's sales effort, the free riding effect reduces retailer's desired effort level, and thus undermines the manufacturer's profit and the overall supply chain performance [15]. To motivate the retailer to improve service level and thus enhance the performance of the supply chain, a supply chain coordination mechanism with service cost sharing between the manufacturer and the retailer should be established [16].

Most of the previous studies assume that channel members are rational-economic men, who always try to maximize their own profits. However, abundant evidence show that decision makers not only care about their own profits, but also the profit difference between the two sides, meaning they concern about fairness. "There is a significant incidence of cases in which firms, like individuals, are motivated by concerns of fairness" in business relationships including channel relationships

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[17]. Each member's own judgment of fairness may play a role on the contract's channel performance [18]. Researches in economics and marketing have demonstrated that fairness is of significant importance in developing and maintaining channel relationships [19-22]. Many empirical or experimental studies illustrate that channel member would sacrifice their own margins for the benefit of their counterpart because of fairness concerns [23, 24]. The channel members should attach importance to fairness concerns, which may bring benefits to them [25].

Therefore, it is critical to study retailers' service strategy when channel members have fairness concerns. This paper considers a manufacturer that sells a product through his direct online channel and a traditional retail store during a sales season. In order to avoid channel conflict and improve service efficiency, the manufacturer outsources his direct channel's service to retailer and gives the retailer a proper percentage of the revenue generated by the dual channel. This paper analyses the retail service and revenue sharing decisions in the following four cases: (1) neither channel member has fairness concerns; (2) only the retailer has fairness concerns; (3) only the retailer has fairness concerns; (4) both channel members have fairness concerns.

The rest of the paper is organized as follows. Section 2 describe the notation and formulates the decision models for the manufacturer and the retailer. Section 3 considers the basic situation that neither channel members have fairness concerns. Section 4 discusses the case when channel members have fairness concerns. Section 5 reports the results of numerical experiments carried out to investigate the impacts of fairness concerns on the manufacturer and retailer's decisions and revenue (or utility). Section 6 gives the concluding remarks and directions for future research.

2 The model

A manufacturer who produces a single product at a unit cost *c* and distributes it through his wholly owned direct online channel and independent retailer channel at a price *p* in a perfectly competitive market, *p* is determined by the market. The manufacturer outsources the direct channel's services to the retailer so that the retailer provides services for the dual channel. The level of the services is denoted by *s*, determining by the retailer, which includes immediate customer support, presale advice, in-store advertising and promotions, technical and shopping assistance, post-sale service, channel assembly services, etc. The manufacturer and the retailer share the total revenue of the dual-channel supply chain, and the manufacturer prorates the total revenue of the dual-channel.

Let D_r and D_d denote the market demand from the retail channel and the direct channel respectively, they mainly depend on the level of service devoted by the retailer. We adopt a linear demand function which has been wildly used in Yue and Liu [26], Huang and Swaminathan [27], Dan et al. [12], it was described as follow:

$$D_d = \theta a - p + \lambda_1 s \, , \tag{1}$$

$$D_r = (1-\theta)a - p + \lambda_2 s \, . \tag{2}$$

The parameter *a* represents the base level of demand rate, supposing $a - 2p > 0$. θ ($0 < \theta < 1$) represents the degree of customer loyalty to the direct channel. The parameter λ_1 and λ_2 ($\lambda_i > 0; i = 1,2$) are the coefficient of service elasticity of D_d and D_r.

With the above notation, the total revenue of the supply chain is:

$$\pi_T = (p-c)(D_d + D_r) \, , \tag{3}$$

the retailer's profit is:

$$\pi_r = k + \varphi \pi_T - c(v) \, , \tag{4}$$

and the manufacturer's profit is:

$$\pi_m = (1-\varphi)\pi_T - k \, , \tag{5}$$

where *k* represents the case when the manufacturer pays the retailer a fixed fee to maintain channel relationship which is irrelevant to the level of service, $\varphi (0 < \varphi < 1)$ acts as the proportion that the retailer gets of the revenue which is decided by the manufacturer, reflecting the significance of the retailer's service. It will rise with the increasing importance of the retailer's service and decline when service makes less impact on demand. $c(s)$ represents the cost of retail service, which has the properties of $dc(s)/ds > 0$ and $d^2c(s)/ds^2 > 0$, and its most common form is: $c(s) = \eta s^2 / 2$.

The paper considers a decentralized dual-channel supply chain under the Stackelberg game; both the manufacturer and the retailer make their own decisions to maximize the utility, where the manufacturer takes the leader role and sets the revenue sharing ratio; in response to the manufacturer's decision, the retailer selects service level, which affects the market demand.

3 Model without fairness concerns

In the traditional decentralized setting, all parties maximize their own monetary payoffs without considering any fairness issues. Under the Manufacturer Stackelberg, the manufacturer takes the retailer's reaction function into consideration for her revenue sharing decisions. Using backward induction, the retailer's best response for any given revenue sharing ratio $\varphi \in (0,1)$, the retailer chooses $s > 0$ to maximize his profits, and his decision problem can be described as bellow:

$$\max_s \pi_r = k + \varphi(p-c)[a - 2p + (\lambda_1 + \lambda_2)s] - \frac{\eta s^2}{2} \, . \tag{6}$$

Taking the first-order partial derivatives of π_r with respect to *s*, and letting the derivatives be zero, that is:

$$\frac{\partial \pi_r}{\partial s} = -\eta s + \varphi(\lambda_1 + \lambda_2)(p-c) = 0 .$$

Taking the second-order partial derivatives of π_r with respect to *s*, we have $\frac{\partial^2 \pi_r}{\partial s^2} = -\eta$.

Since the second order condition for π_r with respect to *s* is negative, the retailer's best response to the φ is:

$$s = \frac{\varphi(\lambda_1 + \lambda_2)(p-c)}{\eta} . \tag{7}$$

This function implies that the retailer's service depend on the given proportion of revenue that dictated by the manufacturer.

The manufacturer anticipates the retailer's best response and incorporates it into his optimization problem, which is given by $\pi_m^* = \max \pi_m(\varphi, s(\varphi))$, which can be written:

$$\max_{\varphi} \pi_m = (1-\varphi)(p-c)[a-2p+(\lambda_1+\lambda_2)s]-k . \tag{8}$$

Substituting Equation (7) into Equation (8), then taking the first-order and second-order partial derivatives of π_m with respect to φ :

$$\frac{\partial \pi_m}{\partial \varphi} = -\frac{(\lambda_1+\lambda_2)^2(p-c)^2\varphi}{\eta} + \frac{(\lambda_1+\lambda_2)^2(p-c)^2 - \eta(a-2p)(p-c)}{\eta},$$

$$\frac{\partial^2 \pi_m}{\partial \varphi^2} = -\frac{(\lambda_1+\lambda_2)^2(p-c)^2}{\eta} .$$

since $\frac{\partial^2 \pi_m}{\partial \varphi^2} < 0$, it implies that there exists a unique optimal revenue sharing ratio φ^* :

$$\varphi^* = \frac{1}{2} - \frac{\eta(a-2p)}{2(\lambda_1+\lambda_2)^2(p-c)} . \tag{9}$$

Substituting Equation (9) into Equation (7), the retailer's best service strategy is given by:

$$s^* = \frac{(\lambda_1+\lambda_2)(p-c)}{2\eta} - \frac{a-2p}{2(\lambda_1+\lambda_2)} \tag{10}$$

Corollary1. The proportion of revenue sharing φ and the level of service *s* were determined by the significance of service in the dual channel, and they will rise with the increasing importance of the retailer's service and decline with the diminishing importance of the retail service in dual-channel.

Proof:

$$\frac{\partial \varphi}{\partial(\lambda_1+\lambda_2)} = \frac{\eta(a-2p)}{(\lambda_1+\lambda_2)^3(p-c)} > 0 ,$$

$$\frac{\partial s}{\partial(\lambda_1+\lambda_2)} = \frac{(p-c)}{2\eta} + \frac{a-2p}{2(\lambda_1+\lambda_2)^2} > 0 .$$

4 Model with fairness concerns

4.1 ONLY THE RETAILER IS CONCERNED ABOUT FAIRNESS

This section considers the case that the retailer has fairness concerns, but the manufacturer does not. The manufacturer maximizes his own profit whereas the retailer maximizes his utility depending on the profits of both members. Cui et al. [22] capture fairness in the members' objectives through the following utility function:

$$U_i = \pi_i + f_i , \quad i \in \{m, r\} , \tag{11}$$

where, U_i stands for the channel member's utility, while π_i represents the monetary profit and f_i denotes channel member's disutility due to the unfairness or inequity. This means that channel member's utility consist of the monetary payoff and the utility of fairness. For the sake of simplification, the paper adopts a modified model [28], which was firstly constructed by Charness and Rabin [29]. Which is:

$$U_r^r = \pi_r - \alpha(\pi_m - \pi_r) . \tag{12}$$

In the text, the subscript "*r*", "*m*" means the parameters correspond to the retailer and the manufacturer, while the superscript "*r*", "*m*", "*b*" means the parameters are corresponding only when the retailer has fairness concern or the manufacturer has fairness concern, or both the retailer and the manufacturer have fairness concerns. α represents the retailer's sensitivity on fairness, α measures the retailer's utility(or disutility) of earning more (less) than the manufacturer, that means if the retailer's monetary payoff is higher (or lower) than the manufacturer's, an advantageous (or disadvantageous) equality occurs, which will result in a utility (or disutility) for the retailer in the amount of α per-unit difference in the two payoffs. When $\alpha = 0$, it means the retailer is fairness neutral, he does not concern fairness, and he only cares about his monetary payoff. When $\alpha = 1$, the retailer concerns fairness extremely, such that the retailer would give up some monetary payoff to move in the direction of more equitable outcomes. Therefore, when the retailer is concerned about fairness, his optimization problem is given below:

$$\max U_r^{\,r} = \max_s \pi_r - \alpha(\pi_m - \pi_r) =$$
$$\max_s (1+2\alpha)k + [(1+2\alpha)\varphi - \alpha]\cdot \tag{13}$$
$$[a-2p+(\lambda_1+\lambda_2)s](p-c) - \frac{(1+\alpha)\eta}{2}s^2.$$

The retailer's best service strategy s^{r*} satisfies:

$$\frac{\partial U_r^{\,r}}{\partial s^r}\Big|_{s^r=s^{r*}} = \tag{14}$$
$$[(1+2\alpha)\varphi - \alpha](\lambda_1+\lambda_2)(p-c) - (1+\alpha)\eta s^{r*} = 0$$

and $\dfrac{\partial^2 U_r^{\,r}}{\partial s^{r2}} = -(1+\alpha)\eta < 0$.

Thus, the retailer's best response to the given φ is:

$$s^r = \frac{[(1+2\alpha)\varphi-\alpha](\lambda_1+\lambda_2)(p-c)}{(1+\alpha)\eta}. \tag{15}$$

Substituting Equation (15) into Equation (8), solving the optimal decision for the manufacturer, the manufacturer's optimal decisions as follows:

$$\varphi^{r*} = \frac{1+3\alpha}{2(1+2\alpha)} - \frac{\eta(1+\alpha)(a-2p)}{2(1+2\alpha)(\lambda_1+\lambda_2)^2(p-c)}. \tag{16}$$

Substituting Equation (16) into Equation (15), the retailer's best service strategy is given below:

$$s^{r*} = \frac{(\lambda_1+\lambda_2)(p-c)}{2\eta} - \frac{a-2p}{2(\lambda_1+\lambda_2)}. \tag{17}$$

Corollary 2. When only the retailer is concerned about fairness, $\varphi^{r*} > \varphi^*$, $s^{r*} = s^*$; φ^{r*} rise with the increasing of α.

Proof:

$$\varphi^{r*} - \varphi^* > 0,\ \frac{\partial \varphi^{r*}}{\partial \alpha} = \frac{1}{2(1+2\alpha)^2} + \frac{\eta(a-2p)}{2(\lambda_1+\lambda_2)^2(p-c)} > 0.$$

Corollary 2 illustrates that if only the retailer cares about fairness, the manufacturer has to consider the retailer's fairness feelings, he will distribute more revenue to the retailer to satisfy the retailer's fairness concerns. If the retailer has stronger fairness concerns, he will obtain a higher proportion of revenue sharing from the manufacturer. However, since the manufacturer has no fairness concerns, the retailer's best service level remains unchanged and stays the same level as the level of neither channel members have fairness concerns.

Corollary 3. When only the retailer has fairness concern, the manufacturer's profits maybe shrinkage because the market demand which is influenced by the retailer's services has not increased, leading to the total supply chain revenue remain unchanged. With the retailer's revenue increased, the manufacturer's revenue will reduce and the retailer's utility will increase as well.

Since the expressions of $\pi_m^{\,*}$, $\pi_m^{\,r*}$, $\pi_r^{\,*}$ and $U_r^{\,r*}$ are complicated, in section 5, the paper will present numerical examples to compare $\pi_m^{\,*}$ with $\pi_m^{\,r*}$ and compare $\pi_r^{\,*}$ with $U_r^{\,r*}$ to prove the corollary 3.

4.2 ONLY THE MANUFACTURER IS CONCERNED ABOUT FAIRNESS

When only the manufacturer cares about fairness, which is similar to section 4.1, the manufacturer's utility function is:

$$U_m^{\,m} = \pi_m - \beta(\pi_r - \pi_m) = [1+\beta-(1+2\beta)\varphi]$$
$$[a-2p+(\lambda_1+\lambda_2)s](p-c) - (1+2\beta)k + \frac{\beta\eta}{2}s^2, \tag{18}$$

β represents the manufacturer's sensitivity on fairness, when $\alpha = 0$, it means the manufacturer has no fairness concerns; when $\alpha = 1$, he concerns fairness extremely, such that the manufacturer would give up some monetary payoff to get a fair shake.

Because the retailer is indifferent to the fairness, his utility function is just the same as the profits function, that is:

$$U_r = \pi_r = \pi' - c(s) = k + \varphi(\pi_t + \pi_t) - \frac{\eta s^2}{2}$$
$$= k + \varphi(p-c)[a-2p+(\lambda_1+\lambda_2)s] - \frac{\eta s^2}{2}. \tag{19}$$

With similarity to the solution process of section 4.1, the retailer's response function is

$$s^m = \frac{\varphi(\lambda_1+\lambda_2)(p-c)}{\eta} \tag{20}$$

Substituting Equation (20) into Equation (18), solving the optimal decision for the manufacturer:

$$\varphi^{m*} = \frac{(1+\beta)(\lambda_1+\lambda_2)^2(p-c) - \eta(1+2\beta)(a-2p)}{(\lambda_1+\lambda_2)^2(p-c)[2(1+2\beta)-\beta(p-c)]}. \tag{21}$$

Substituting Equation (21) into Equation (20), the retailer's best service strategy is:

$$s^{m*} = \frac{(1+\beta)(\lambda_1+\lambda_2)^2(p-c) - \eta(1+2\beta)(a-2p)}{\eta(\lambda_1+\lambda_2)[2(1+2\beta)-\beta(p-c)]}. \tag{22}$$

Corollary 4. When only the manufacturer has fairness concern, (a) if $p > p^m{}_2$, then $\varphi^{m*} > \varphi^*, s^{m*} > s^*$, $\dfrac{\partial \varphi^{m*}}{\partial \beta} > 0$, $\dfrac{\partial s^{m*}}{\partial \beta} > 0$; (b) if $p^m{}_1 < p < p^m{}_2$, then $\varphi^{m*} > \varphi^*, s^{m*} > s^*$, $\dfrac{\partial \varphi^{m*}}{\partial \beta} < 0$, $\dfrac{\partial s^{m*}}{\partial \beta} < 0$; (c) if $p < p^m{}_1$, then $\varphi^{m*} < \varphi^*$, $s^{m*} < s^*$, $\frac{\partial \varphi^{m*}}{\partial \beta} < 0$, $\frac{\partial s^{m*}}{\partial \beta} < 0$, where $p^m{}_1 = \frac{(c+2)(\lambda_1+\lambda_2)^2 + a\eta}{(\lambda_1+\lambda_2)^2 + 2\eta}$,

$$p^m{}_2 = \frac{[c+2(1+2\beta)](\lambda_1+\lambda_2)^2 + a\eta}{(\lambda_1+\lambda_2)^2 + 2\eta}.$$

Proof:

$$\varphi^{m*} - \varphi^* = \frac{\beta(\lambda_1+\lambda_2)^2(p-c-2) - \beta\eta(a-2p)}{2(\lambda_1+\lambda_2)^2[2(1+2\beta) - \beta(p-c)]},$$

$$s^{m*} - s^* = \frac{\beta(\lambda_1+\lambda_2)^2(p-c-2) - \beta\eta(a-2p)}{2\eta(\lambda_1+\lambda_2)[2(1+2\beta) - \beta(p-c)]},$$

when

$$\frac{\beta(\lambda_1+\lambda_2)^2(p-c-2) - \beta\eta(a-2p)}{2(1+2\beta) - \beta(p-c)} > 0,\ \varphi^{m*} - \varphi^* > 0,$$

$s^{m*} - s^* > 0$, then $p > \frac{(c+2)(\lambda_1+\lambda_2)^2 + a\eta}{(\lambda_1+\lambda_2)^2 + 2\eta} = p^m{}_1$.

$$\frac{\partial \varphi^{m*}}{\partial \beta} = \frac{-2(1+2\beta)(\lambda_1+\lambda_2)^2 + (\lambda_1+\lambda_2)^2(p-c) - \eta(a-2p)}{(\lambda_1+\lambda_2)^2[2(1+2\beta) - \beta(p-c)]^2},$$

$$\frac{\partial s^{m*}}{\partial \beta} = \frac{-2(1+2\beta)(\lambda_1+\lambda_2)^2 + (\lambda_1+\lambda_2)^2(p-c) - \eta(a-2p)}{\eta(\lambda_1+\lambda_2)[2(1+2\beta) - \beta(p-c)]^2},$$

when

$$-2(1+2\beta)(\lambda_1+\lambda_2)^2 + (\lambda_1+\lambda_2)^2(p-c) - \eta(a-2p) > 0,$$

then

$$\frac{\partial \varphi^{m*}}{\partial \beta} > 0,\ \frac{\partial s^{m*}}{\partial \beta} > 0,$$

note that

$$p > \frac{[c+2(1+2\beta)](\lambda_1+\lambda_2)^2 + a\eta}{(\lambda_1+\lambda_2)^2 + 2\eta} = p^m{}_2.$$

4.3 BOTH THE MANUFACTURER AND THE RETAILER ARE CONCERNED ABOUT FAIRNESS

When both channel members have fairness concerns, they no longer strive to maximize only their monetary payoff. Instead, their objective is to maximize their utility, which define as

$$\max U_r{}^b = \max_s \pi_r - \alpha(\pi_m - \pi_r) \tag{23}$$

$$\max U_m{}^b = \max_\varphi \pi_m - \beta(\pi_r - \pi_m) \tag{24}$$

As the manufacturer is the Stackelberg leader, which is similar to the solution procedure of section 4.1, the optimal strategies for both channel members are given by

$$\varphi^{b*} = \frac{[\alpha(1+\alpha)(1+2\beta) + (1+\alpha)(1+2\alpha)(1+\beta) - \alpha\beta(1+2\alpha)(p-c)](\lambda_1+\lambda_2)^2(p-c) - \eta(1+\alpha)^2(1+2\beta)(a-2p)}{(1+2\alpha)(\lambda_1+\lambda_2)^2(p-c)[2(1+\alpha)(1+2\beta) - (1+2\alpha)\beta(p-c)]}, \tag{25}$$

$$s^{b*} = \frac{(1+\alpha+\beta)(\lambda_1+\lambda_2)^2(p-c) - \eta(1+\alpha)(1+2\beta)(a-2p)}{\eta(\lambda_1+\lambda_2)[2(1+\alpha)(1+2\beta) - (1+2\alpha)\beta(p-c)]}. \tag{26}$$

Corollary 5. When both channel members care about fairness, the impact of φ on s is greater than it when both channel members have no fairness concerns.

Proof:

$$\frac{\partial s}{\partial \varphi} = \frac{(\lambda_1+\lambda_2)(p-c)}{(1+\alpha)\eta},$$

$$\frac{\partial s^r}{\partial \varphi} = \frac{(1+2\alpha)(\lambda_1+\lambda_2)(p-c)}{(1+\alpha)\eta} > \frac{\partial s}{\partial \varphi},$$

$$\frac{\partial s^m}{\partial \varphi} = \frac{(\lambda_1+\lambda_2)(p-c)}{\eta} > \frac{\partial s}{\partial \varphi},$$

$$\frac{\partial s^b}{\partial \varphi} = \frac{(1+2\alpha)(\lambda_1+\lambda_2)(p-c)}{(1+\alpha)\eta} > \frac{\partial s}{\partial \varphi}.$$

In this section, due to the fact that the expressions of φ^{b*} and s^{b*} are explicated, it is not easy to observe their variation which affected by α and β. It is also difficult to compare φ^{b*} (or s^{b*}) with φ^* (or s^*), the paper will analyse by numerical example.

5 Numerical analysis

According to the above theoretical analysis, the result shows that the fairness concern has an important impact on the optimal decisions and utilities of the channel members as well as the profits of the dual-channel supply chain. In this section, by conducting several numerical examples, some related issues will be illustrated.

Under the constraints of $0 < \varphi < 1$ and $s > 0$, assuming $a = 100$, $p = 5$, $c = 1$, $\lambda_1 = 2$, $\lambda_2 = 3$, $\eta = 0.5$, $k = 20$, $\alpha, \beta \in [0,1]$.

When neither the manufacturer nor the retailer cares about fairness, the retail service level $s^* = 11$, the revenue sharing ratio $\varphi^* = 0.275$, the channel members' profits are $\pi_m{}^* = 400.5$ and $\pi_r{}^* = 149.25$, the total profits

$\pi_T^* = 549.75$. In this case, the dual-channel supply chain's total utility is equal to its total profits, where $U_T^* = \pi_T^* = 549.75$.

5.1 ONLY THE RETAILER IS CONCERNED ABOUT FAIRNESS

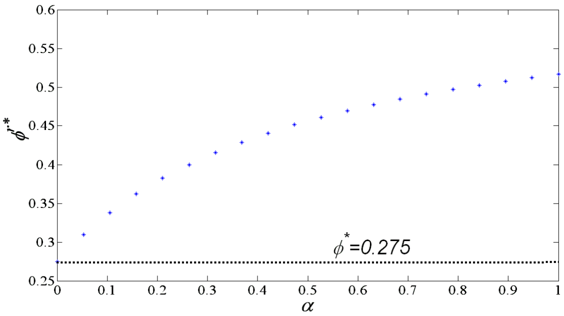

FIGURE 1 The impact of α on φ

Figure 1 shows the impact of the retail service on the manufacturer's revenue sharing decision, $\varphi^{r*} \in [0.275, 0.517]$, it is higher than the case where both channel members are completely rational economic man , this is because the retailer cares about fairness and the manufacturer needs to consider the retailer's preference by giving more revenue to the retailer. So φ^{r*} augments with the increase of α ,but the growth rate is decline, which reflects that the manufacturer is sensitive to the retailer's fairness concerns at first, however, as the retailer's fairness concern enhances, the manufacturer is gradually accustomed to the retailer's concerns as such the φ will grow slowly. As the retailer gets more revenue from the manufacturer, the retail service remains unchanged and stays the same as the situation that neither them has fairness concerns. As a result, the market demand affected by the retailer's services has not increased, which leads to the supply chain's total revenue keeps unchanged. Then, with the growing of φ^{r*}, the manufacturer's revenue is decreasing as the retailer's revenue is increasing.

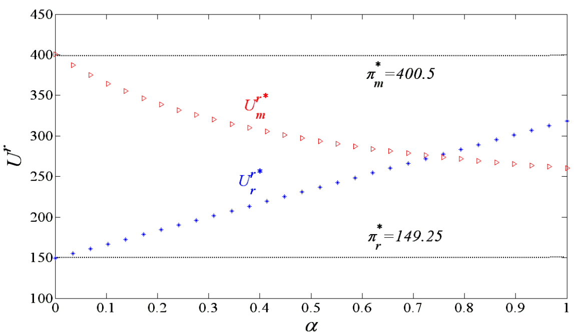

FIGURE 2 The impact of α on the channel members' utilities

As shown in Figure 2, the manufacturer's utility $U_m^{r*} \in [400.5, 260.33]$ is equal to his profit, reducing with the α increasing; the retailer's utility $U_r^{r*} \in [149.25, 318.5]$ exceeds his profit, increasing with the α increasing. The total utility of the dual-channel supply chain $U_T^{r*} \in [549.75, 578.83]$ exceeds the total revenue of the supply chain, where $U_T^{r*} > \pi_T^{r*}$. This scenario is a zero-sum game, and it maybe prejudicial to the stability of the supply chain.

5.2 ONLY THE MANUFACTURER IS CONCERNED ABOUT FAIRNESS

Only when the manufacturer has fairness concern, the revenue sharing ratio (φ^m) is rising with the enhancement of manufacturer's fairness concerns (β), so the retailer will get more revenue from the manufacturer, as shown in Figure 3, where the revenue sharing ratio $\varphi^{m*} \in [0.275, 0.325]$.

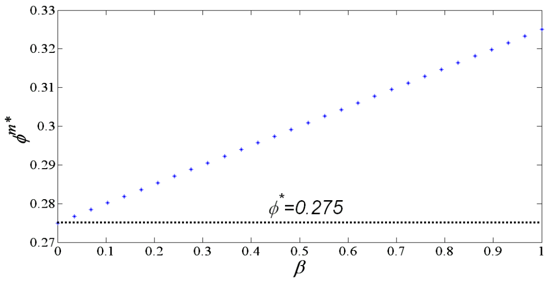

FIGURE 3 The impact of β on φ

Comparing to the case where only the retailer is concerned about fairness, the manufacturer's fairness concern has less impact on the revenue sharing ratio than the retailer's fairness concern, so $\varphi^* < \varphi^{m*} < \varphi^{r*}$. To satisfy the manufacturer's fairness concern and increase the market demand, with the increase of β ,the retailer needs to improve his retail service (s^m), as shown in Figure 4, the retailer's service $s^{m*} \in [11, 13]$, $s^{m*} > s^{r*} = s^*$.

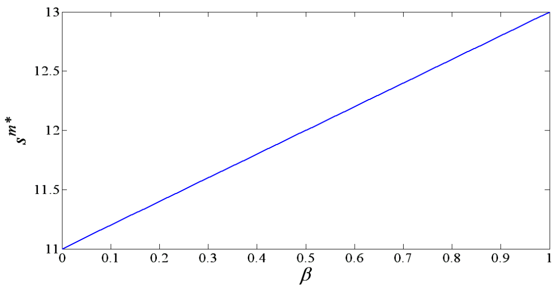

FIGURE 4 The impact of β on the retailer's service

Retail service will promote sales, bringing about an increase in total revenue of the dual-channel supply chain. From Fig.5, with the increase of β, both the manufacturer's and the retailer's utility increase, the retailer's utility ($U_r^{m*} \in [149.25, 179.25]$) is equal to his profit, and the manufacturer's utility $U_m^{m*} \in [400.5, 617.75]$ is greater than his profit, so the supply chain's total utility $U_T^{m} \in [549.75, 797]$ exceeds its total profits, where $U_T^{m*} > \pi_T^{m*}$, and it exceeds U_T^{*} and U_T^{r*}.

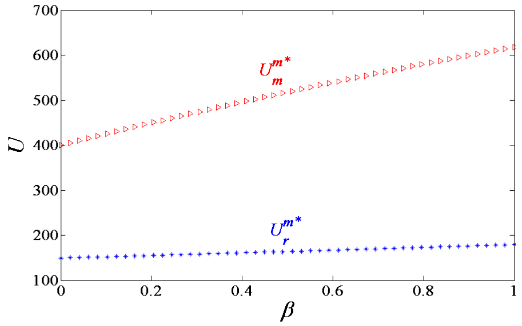

FIGURE 5 The impact of β on the channel members' utilities

It reflects that the manufacturer has fairness concern is beneficial to both sides, which to leads to a "win–win" situation. Besides, it also means that it is a Pareto improvement when the manufacturer converts from complete rationality to fairness concern.

5.3 BOTH THE MANUFACTURER AND THE RETAILER ARE CONCERNED ABOUT FAIRNESS

Since the manufacturer and the retailer are fair-minded, the revenue sharing ratio $\varphi^{b*} \in [0.275,1)$, a higher proportion than φ^{*}, φ^{r*} and φ^{m*}. As shown in Figure 6, the revenue sharing ratio φ^{b*} rises with α and β, when α and β below a certain threshold, that is $\alpha,\beta < 0.6$. α has a strong effect on φ^{b*} than β, and φ^{b*} increases slightly with the rise of β. When both channel members have strong sense of fairness, where $\alpha,\beta > 0.6$, φ^{b*} increases sharply with the rise of α or β.

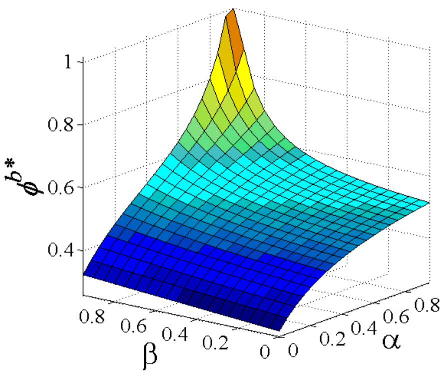

FIGURE 6 The impact of α and β on φ

This demonstrates that when both channel members are concerned about fairness, the manufacturer will take full account of the retailer's fairness concern; the retailer's revenue relies heavily on his fairness concern, when the retailer is obviously fair-minded, he will get much revenue from the manufacturer, and otherwise he will get less when he cares little about fairness.

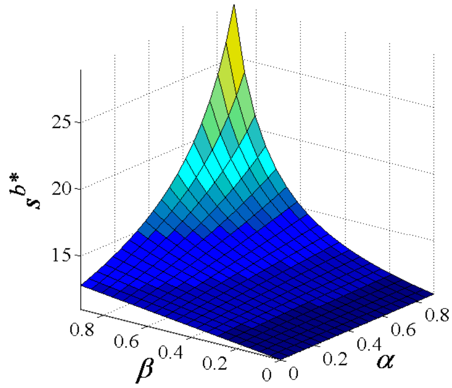

FIGURE 7 The impact of α and β on the retailer's service

Just as the variation of the revenue sharing ratio, the retailer's service is affected by both channel members' fairness concerns; it will increase with α and β, as shown in Figure 7, $s^{b*} \in [11,40)$. When $\beta < 0.6$, the retailer lacks the inclination to improve service, and the retail service is not nearly affected by his fairness concern, so the service level remains largely unchanged when $\alpha \in [0,1]$. If $\alpha < 0.6$, even though the manufacturer is very concerned about fairness, the retail service increases slowly with the rise of β. When $\alpha,\beta > 0.6$, the retail service is increasing sharply with the rise of α or β, and it is obviously higher than any of the above case.

As shown in Figures 8 and 9, the manufacturer's utility and the retailer's utility are affected by their fairness concerns. The manufacturer's utility (U_m^{b*}) decreases with the rise of α and β, $U_m^{b*} \in [-768.84,605.96]$, and it mainly affected by β.

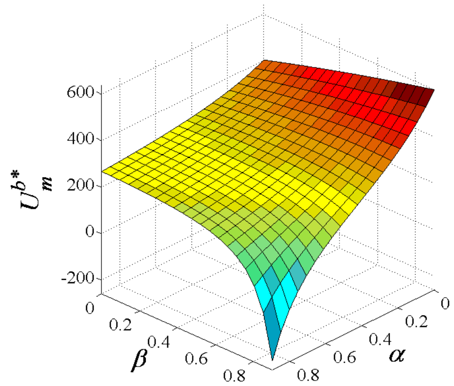

FIGURE 8 The impact of α and β on the manufacturer's utility

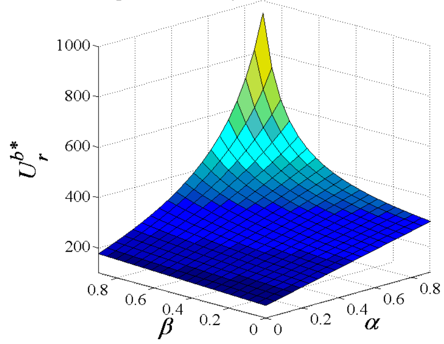

FIGURE 9 The impact of α and β on the retailer's utility

When β is low, U_m^{b*} decreases slowly with the rise of α; when β is high, U_m^{b*} decreases sharply with the rise of α. U_m^{b*} increases with the rise of β only when α is quite low. Contrary to U_m^{b*}, U_r^{b*} increases with the rise of α and β, when both channel members are strongly concerned about fairness, U_r^{b*} will increase quickly with the rise of α or β. This implies that channel members' strong fairness concerns are beneficial to the retailer but disadvantageous to the manufacturer. Most firms in reality care about the fair outcomes in business relations, and the impact of fairness concerns can be expected to be most significant for members' decision making and utility, so this scenario can well reflect the real-world conditions. It enlightens us that the retailer should lower his fairness concern and the manufacturer should enhance his fairness concern, which will be good for both channel members and the stability of the dual-channel supply chain.

6 Conclusions

This paper takes an initial step to incorporate fairness concerns of channel members into the study of revenue sharing and cooperative service in a dual-channel supply chain, and examine the effect of fairness on the supply chain partners' strategies and utility, as well as compare the situations when neither channel members have fairness concern. The study finds that only when the retailer is concerned about fairness, he will get more revenue from the manufacturer and remain his retail service the same level when both sides are complete rationality, resulting in the increase of retailer's utility and the decrease of manufacturer's utility. Unlike the retailer's fairness concern, only when the manufacturer is fair-minded, the retailer will improve service level, which leads to the increase in the total revenue of the supply chain, bringing about a good result for both channel members. When both the manufacturer and the retailer are strongly concerned about fairness, the retailer is likely to provide a high level of service and maximizes the total revenue of the supply chain, while the manufacturer divides a great part of the total revenue to the retailer and he gets little. In this case, the retailer has a great utility but the manufacturer has a negative one, as such the retailer is the great beneficiaries.

The channel members' fairness concerns may heighten the revenue sharing ratio, the service level and the equilibrium utility of the manufacturer as well as the whole channel. Interestingly, there exists a Pareto improvement of both the utilities of the manufacturer and the retailer when a manufacturer without fairness concern becomes fair-minded. These results suggest that both the manufacturer and the retailer should attach importance to fairness concerns, and the best arrangement is that the manufacturer care strongly about fairness and the retailer cares little about it, which is beneficial to both channel members.

Although the analysis has derived some useful insights, it is worth mentioning that this research can be extended in several directions. First, the paper assume the manufacturer to be the Stackelberg leader in this paper, but there are practical examples of large retailers (e.g., Wal-Mart, Amazon) as channel leaders. Thus it is an interesting direction that the retailer acts as the Stackelberg leader of the channel. Second, the paper does not examine how incomplete information may affect channel interactions in the presence of fairness concerns. For instance, a manufacturer may not know a retailer's service cost to estimate whether it has attained its equitable payoffs or not. Other extensions are worthy of studying including investigating channel members' decision making under fairness concerns when the market demand is uncertain or incorporating consumer fairness concern to explore their implications for channel coordination.

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