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A dual-channel supply chain model considering supplier's mental accounting and retailer's fairness concerns

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Abstract

We investigate a dual-channel supply chain with a supplier and a retailer. The supplier has the tendency to open up a direct sales channel because of the e-commerce advantages. We consider the influence of the retailer's fairness concerns about the new direct sales channel on the optimal decisions and the supplier's mental accounting on profits gained from both channels. Based on a Stackelberg game model, we analyze the equilibrium prices for each supply chain member. Then, we apply a numerical study to illustrate how the equilibrium prices depend on the extent of the behavior. Our results demonstrate that a retailer's fairness concerns have no positive influence on increasing its profit; and when consumers highly accept the direct sales channel, it would decrease the retailer's profit. Moreover, establishing a direct sales channel can diminish the influence of fairness concerns on the supplier's profit to some extent, and mental accounting will weaken the supplier's impetus to set up a direct sales channel to deter the retailer.

Keywords: Dual-channel supply chain; Fairness; Mental accounting;

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1. Introduction

With the development of e-commerce, more and more sellers prefer establishing a direct sales channel in addition to the traditional retail channel. Compared to the traditional vertical retail channel, the dual channel (D-C) could improve efficiency of supply chain systems. Park and Keh (2003) find that after establishing a direct sales channel, the supplier's profit increases and the retailer's profit decreases; however, the total channel incomes increase, and consumers purchase the product at a lower price. Yue and Liu (2006) investigate D-C supply chains under Gaussian demand with no market potential. The authors conclude that opening up a direct sales channel has negative impact on retailers but can increase incomes of suppliers and improve efficiency of the supply chain when the price meets certain conditions.

In the studies of D-C supply chains, the topic of optimal pricing decision has gained wide attention. Chiang et al. (2003) demonstrate the optimal pricing decisions of a supplier and a retailer when the supplier is able to establish a direct sales channel. The optimal decision for the supplier is to reduce the demand to 0 by controlling the price in the direct sales channel, by which the conflicts between the two channels can be avoided and the efficiency of the traditional channel may be improved, thus the supplier's and retailer's profits are increased. In order to raise the whole channel profits and awaken the double marginal effect, the supplier can overawe the retailer to restrict the pricing decision by setting up the direct sales channel. Dumrongsiri et al. (2008) investigate the pricing strategies of a D-C supply chain and find that the supplier and the retailer should equally share the market in the equilibrium. Moreover, the existence of the D-C supply chain depends on the marginal cost and demand fluctuation; when there are high marginal cost and high wholesale price in the market, it is better for the supplier to set up a direct sales channel. Dong and Chen (2015) build a two-stage D-C model in which the supplier gives up making the price decision and equates the online price with the offline price; there would be a Pareto improvement to achieve the optimal price. They find that the optimal price and stock quantity have certain stability.

In recent years, scholars pay more attention to the influence of behavioral factors for a lot of areas (Zhan, et al, 2016). On decisions of D-C supply chains, Li and Zhang (2012) investigate the influence of risk aversion on the decisions of a D-C supply chain and find that the level of integration improved the total benefit of the supply chain. In addition, the direct selling price and the retail price in such a supply chain are lower than that of the risk-neutral one. Li et al. (2014) build a supply chain model with a loss-neutral manufacturer and a loss-averse retailer. The result indicates that when the demand is normal distributed, with the increasing of the degree of loss aversion, the retail price and the profit of the direct channel will decrease; the total profit of the supplier will increase first and then decrease. Moreover, Li et al. (2015) study a D-C supply chain with a loss-averse retailer in the condition of information asymmetry and find that the supplier's income and the retailer's utility depend on the supplier's cost and the degree of the retailer's loss aversion when the retailer has more market information than the supplier.

Kahneman and Tversky (1990) point out that people evaluate decisions by classifying accounts mentally. The procedure is mental accounting. Due to mental accounting, people deal with different incomings and outgoings with various attitudes, thus making diverse decisions. In the D-C supply chain, the supplier's attitude to incomes from different channels would be different because of the mental accounting behavior and as a result this influences the supplier's price decisions. In contrast to the supplier's mental accounting, the extant research has pointed out that a direct sales channel would hurt the retailer's profit. For this reason, the retailer would consider the direct channel as unfair and lacking in cooperation with the supplier (Fehr and Schmidt, 1999). In the D-C supply chain, it is reasonable to incorporate behavioral factors of the supplier's mental accounting and the retailer's fairness concerns. To the best of our knowledge, there is no study considering both mental accounting and fairness concerns in D-C supply chains. This study fills this gap by setting up a D-C supply chain pricing decision model considering the supplier's mental accounting and the retailer's fairness concern, analyzing the optimal decisions for each member of the D-C supply chain.

Our study contributes to the research of D-C supply chain. First, we first introduce the retailer's fairness concerns and the supplier's mental accounting to the D-C supply chain. By considering the behavior factors, the D-C supply chain model is closer to the actual and the result of theoretical analysis based on it is more constructive. Second, by considering the influence of the two behavior factors, we find that both the retailer's fairness concerns and the supplier's mental accounting have huge impacts on the decisions and profits of the supplier and retailer. Third, based on the model and numerical analysis, some functional implications are presented for each member in the D-C supply chain. For instance, the retailer should not consider fairness for it has no positive impact on its profit and the supplier should establish a direct sales channel for it can diminish the influence of fairness concerns in some cases.

This paper is structured as follows. In the next section, we formulate a model for D-C supply chain. In Section 3, we give analytic results of the theoretical model. In Section 4, we develop numerical analysis. In Section 5, concluding remarks are to be submitted.

2. Model Specification

We introduce a basic model of a D-C supply chain, which is described as a Stackelberg game between a supplier and a retailer. Different from the previous studies on D-C supply chains, we take into account the influence of the behavioral factors — fairness concerns of the retailer and mental accounting of the supplier.

Let the variable p denote a product's selling price, and let the variable v denote the consumer's willingness to pay for a product from the retailer. We assume heterogeneous consumers with a total size of 1 and with individual value of v uniformly distributed in the price range $[0,1]$. It is clear that consumers will buy a product as long as the net surplus value of $v-p$ is larger than 0. That is, each consumer with v located in the range of $[p,1]$ will buy a product. Let $\theta(\in[0,1])$ be a consumer's acceptability for purchasing from the direct channel (Chiang et al., 2003). Then, θv is a consumer's willingness to pay for a product directly online from the supplier. Let p_r and p_d denote the selling price for the retailer (retail channel) and for the supplier (direct channel), respectively. Then, a consumer's net surplus value for purchasing a product through the direct channel is $\theta v-p_d$; and there are sales in the direct channel if $\theta v-p_d$ is not less than 0.

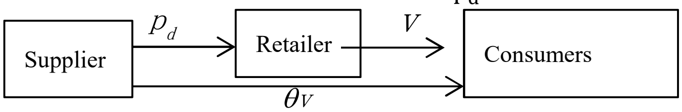

Fig. 1. The D-C supply chain game

If v equals to p_r, it represents the indifferent price for consumers whether to buy the product from the retail channel or not to buy the product. When v equals to p_d/θ, it represents the indifferent price whether to buy the product from the direct channel or not to buy the product. When v equals to $(p_r-p_d)/(1-\theta)$, it represents the indifferent price from buying from the retail channel or the direct channel. Based on the definition of the indifferent prices, we have the demand equation of the D-C supply chain model as

$$Q_r=\begin{cases}1-\frac{p_r-p_d}{1-\theta} & \text{if } \frac{p_d}{\theta}\le p_r\\ 1-p_r & \text{otherwise}\end{cases},\quad Q_d=\begin{cases}\frac{\theta p_r-p_d}{\theta(1-\theta)} & \text{if } \frac{p_d}{\theta}\le p_r\\ 0 & \text{otherwise}\end{cases},\tag{1}$$

where Q_r is the number of products sold in the retail channel, and Q_d is the number of products sold in the direct channel. Let c_r be the cost of a unit product incurred in the retail channel, and let c_d be the cost of a unit product incurred in the direct channel. Denoting by π_m and π_r the supplier's profit and the retailer's profit, respectively, we have

$$\pi_m=(\omega-c_r)Q_r+(p_d-c_d)Q_d,\ \pi_r=(p_r-\omega)Q_r.\tag{2}$$

As the supplier has more power in the supply chain, a fair-minded retailer is more likely to consider the gap between his own income and the supplier's when he makes decisions. If the gap between their incomes gets wider, the willingness to cooperate with the supplier will be weakened. On the basis of Fehr and Schmidt (1999), the retailer's utility equation is

$$U_r = \pi_r - \alpha \max\{\mu\pi_m - \pi_r, 0\}, \tag{3}$$

where the parameter α (≥ 0) captures the degree of fairness concerns, and the parameter μ is a scale parameter, where $0 < \mu \leq 1$. It is reasonable to assume the retailer compares his own income with the supplier's income multiplied by the scale parameter (Cui et al., 2010).

In accordance with the theory of mental accounting, people have different attitudes to the same income from various situations in practice (Kahneman and Tversky, 1990; Thaler, 1985). It is believed that the incomes from different channels may have different meanings for the supplier. Thaler (1985) come up with four principles of mental accounting including separating multiple incomes, integrating multiple losses, integrating large income with small loss, and separating small income from heavy loss. Kahneman and Tversky (1990) demonstrate the concept of a "value function" in the prospect theory, which presents that human beings like to evaluate the incomes separately. The supplier is likely to separate his incomes into different mental accounts when making decisions as the prediction of the income-separate principles and the prospect theory.

In view of the mental accounting factor of the supplier, we replace the supplier's profit equation with the utility equation to illustrate the actual utility of the supplier:

$$U_m = (w - c_r)Q_r + (p_d - c_d)Q_d - \delta I_A(Q_r Q_d), \tag{4}$$

where $I_A(Q_r Q_d)$ is an indicator function, and A is the set $\{0,1\}$. If $Q_r Q_d$ is 0, the indicator function I is equal to 1. If $Q_r Q_d$ is not 0, the indicator function I is equal to 0. The parameter $\delta, \delta > 0,$ is the supplier's willingness to separate his income.

From Equation (4), when the supplier does not open a dual channel, i.e., $Q_r Q_d = 0$, the indicator function $I_A(Q_r Q_d) = 1$. In this case, the utility U_m decreases with the increase of the willingness parameter δ, due to the influence of separate-income willingness from mental accounting. In contrast, when the supplier opens a dual channel, i.e., $Q_r Q_d = 1$, the indicator function $I_A(Q_r Q_d) = 0$. In this case, the income of the supplier is separated into the two channels, thus the separate-income willingness will not exert an influence on the utility U_m.

Considering the supplier's mental accounting, the supplier makes his decisions to maximize his utility (Equation (4)) by considering the retailer's decisions and the demand distribution at first. And then, the retailer decides the retail price p_r to maximize his profit (Equation (2)) by knowing the decisions of the supplier.

3. Model Analysis

We use a backward method to analyze the subgame perfect equilibrium. To avoid trivial cases, it is reasonable to assume that the wholesale price, at which the supplier sells a product to the retailer, is less than the selling price in the direct channel, i.e., $\omega \leq p_d$. Under conditions of $\omega \leq p_d$ and $p_d/\theta < p_r$, the solution area is defined as the free-competition region R1. Under conditions of $\omega \leq p_d$ and $p_r = p_d/\theta$, which is the critical state that the direct-channel sales volume is zero but there can be a hidden threat posed to the retail channel, the solution area is named as the direct-channel-threat region R2. Under conditions of $\omega \leq p_d$ and $p_d/\theta > p_r$, the direct channel loses its competitive power and only the retail channel has sales; the solution area is defined as the retail-channel-advantage region R3. We begin with the model with fairness concerns only and then later consider the model with both behaviors.

Proposition 1 If $\mu\pi_m - \pi_r \leq 0$, the optimal retail price $p_r^* = \frac{1-\theta+p_d+\omega}{2}$ for R1, $p_r^* = \frac{p_d}{\theta}$ for R2, and $p_r^* =$

$\frac{1+\omega}{2}$ for R3; and if $\mu\pi_m - \pi_r \geq 0$, the optimal retailing price $p_r^* = \frac{1-\theta+p_d+\omega}{2} + \frac{\alpha\mu(\omega+p_d-c_r-c_d)}{2(1+\alpha)}$ for R1, $p_r^* = \frac{p_d}{\theta}$ for R2, and $p_r^* = \frac{1+\omega}{2} + \frac{\alpha\mu(\omega-c_r)}{2(1+\alpha)}$ for R3.

Anticipating the retailer's selling price of p_r^*, the supplier decides the optimal wholesale price of ω^* and the optimal direct channel selling price of p_d^*.

Proposition 2 If $\frac{\theta}{2-\theta} \geq \frac{c_r}{\theta}$, the supplier's optimal decisions are $\omega^* = p_d^* = \frac{(1+\alpha)\theta-\alpha\mu\theta c_r}{2(1+\alpha)-\theta(1+\alpha+\alpha\mu)}$; and if $\frac{\theta}{2-\theta} \leq \frac{c_r}{\theta}$, the supplier's optimal decisions are $\omega^* = p_d^* = \frac{(1+c_r)(1+\alpha)-2\alpha\mu c_r}{2(1+\alpha-\alpha\mu)}$.

Regardless of the factor of fairness or not, the overall optimal solution is located in R2 or R3. The optimal solution of R2 is a critical value, and it will not change with the factor of fairness. In R3, the optimal profits of the suppler and the fair-minded retailer become $\pi_m = \frac{(1-c_r)^2(1+\alpha)(1+\alpha-3\alpha\mu)}{8(1+\alpha-\alpha\mu)^2}$ and $\pi_r = \frac{(1-c_r)^2(1+\alpha-3\alpha\mu)}{16(1+\alpha-\alpha\mu)}$, which are clearly less than the counterparts without considering the retailer's fairness concerns. In addition, we have $\frac{(1+\alpha-3\alpha\mu)}{(1+\alpha-\alpha\mu)} \leq \frac{(1+\alpha)(1+\alpha-3\alpha\mu)}{(1+\alpha-\alpha\mu)^2} \leq 1$, thus it is clear that $\pi_m \geq \pi_r$. It is shown that if the retailer considers fairness, the income of the overall system will decrease, and the retailer will suffer from a greater loss. In the D-C supply chain, it is unfavorable for the retailer to take fairness into consideration.

Proposition 2 illustrates the supplier's optimal decisions when the retailer cooperates. However, if the retailer's utility is smaller than zero by considering fairness, the retailer will not cooperate with the supplier, which will break the former balance and overthrow the original optimal solution of the supplier. If $\mu\pi_m - \pi_r \leq 0$, the fairness parameter α does not influence the optimal solution; if $\mu\pi_m - \pi_r \geq 0$, we should limit the variation of the fairness parameter α into a certain range to ensure that the optimal solution in Proposition 2 still holds. That is, the fairness parameter α satisfies the following inequality:

$$U_r = (1+\alpha)\pi_r - \alpha\mu\pi_m \geq 0. \tag{5}$$

When the profit of the supplier in R2 is not smaller than that in R3 (which is noted as $\pi_{m2} \geq \pi_{m3}$), the optimal solution of the supplier is located in R2, and then the equilibrium solution for the retailer is $p_r^* = \frac{p_d}{\theta}$. In this case, $\pi_m = \frac{(\theta-c_r)^2}{4\theta}$ and $\pi_r = \frac{(1-\theta)(\theta^2-c_r^2)}{4\theta^2}$. Then, we have

$$0 \leq \alpha \leq \frac{(1-\theta)(\theta+c_r)}{\mu\theta(\theta-c_r)-(1-\theta)(\theta+c_r)}. \tag{6}$$

For $\mu\pi_m - \pi_r \geq 0$, we have

$$\frac{(1-\theta)(\theta+c_r)}{\theta(\theta-c_r)} \leq \mu \leq 1. \tag{7}$$

If the inequality (7) holds and α is larger than $\frac{(1-\theta)(\theta+c_r)}{\mu\theta(\theta-c_r)-(1-\theta)(\theta+c_r)}$, the retailer's utility is less than 0. In this case, the optimal solution of the retailer is to refuse to cooperate with the supplier.

When the profit of the supplier in R2 is not larger than that in R3 (which is noted as $\pi_{m2} \leq \pi_{m3}$), the supplier's optimal solution is located in R3. In this case, the equilibrium solution of the retailer is $p_r^* = \frac{1+\omega}{2} + \frac{\alpha\mu(\omega-c_r)}{2(1+\alpha)}$, and $\pi_m = \frac{(1-c_r)^2(1+\alpha)(1+\alpha-3\alpha\mu)}{8(1+\alpha-\alpha\mu)^2}$ and $\pi_r = \frac{(1-c_r)^2(1+\alpha-3\alpha\mu)}{16(1+\alpha-\alpha\mu)}$. Then, we have $U_r \leq 0$ and the retailer's optimal decision is to refuse to cooperate with the supplier if

$$\alpha > \frac{\sqrt{9\mu^2+12\mu-4}-3\mu}{2(3\mu-1)}. \tag{8}$$

In conclusion, when the retailer refuses to cooperate with the supplier, it can be regarded as p_r is close to 1.

The optimal solution of the supplier is $p_d^* = \frac{\theta + c_d}{2}$, and $\pi_r^* = 0$ and $\pi_m^* = \frac{(\theta - c_d)^2}{4\theta}$.

We then consider the supplier's mental accounting behavior. In view of the mental accounting, the supplier may separate his incomes into different mental accounts when making decisions. The utility of the supplier considering the factor of mental accounting in R1 and R2 is as shown in Equation (4), in which $\mathrm{I}_A(Q_r Q_d)$ is an indicator function. In accordance with the definition of R1, R2 and R3, R1 is the free-competition region for the two channels and the two channels both generate sales volume, i.e., $Q_r Q_d$ is not equal to 0, thus the utility of the supplier is $\mathrm{U}_{m1} = \pi_{m1} = (w - c_r)Q_r + (p_d - c_d)Q_d$. In R2, it has two sales channels, but only retail channel generates sales volume, thus the utility of the supplier is $\mathrm{U}_{m2} = (w - c_r)Q_r - \delta$. R3 is the retail-channel-advantage region, in which the supplier does not have the motivation to open a direct sales channel, thus there is no willingness to separate the income, and the utility of the supplier is $\mathrm{U}_{m3} = (w - c_r)Q_r$.

Now considering the influence of the mental accounting, only the retail channels generate sales volume in R2, and the supplier having the intention to separate the income and the utility equation is under the condition

$$\delta \geq \frac{2\theta^2 - (c_r + 1)^2\theta + 2c_r^2}{8\theta}. \tag{9}$$

The gain of the supplier establishing a direct channel is not enough to make up for the loss of not achieving the income separation. Therefore, to maintain the present status, he is very likely not to open a direct channel when making decisions.

Proposition 3: A supplier prefers not to open up a direct sales channel only for deterring the retailer when the mental accounting behavior parameter $\delta \geq \frac{2\theta^2 - (c_r + 1)^2\theta + 2c_r^2}{8\theta}$.

We have shown that opening a direct channel may benefit the supplier. However, after considering the mental accounting of the supplier, we conclude that the motivation of opening a direct channel is reduced. One of the fundamental reasons is that we take the assumption of all consumers having positive preference for the traditional retail channels, which assumption is also adopted in literature (Chiang et al., 2003). Therefore, in the critical region R2, all consumers will choose to buy the products in the traditional retail channel. However, the preference of consumers for channels may not be the same. It should be paid attention that whether changing the basic assumption has an impact on the conclusion of the mental accounting model or not. We initially assume that in the critical region R2, all consumers buy products in the retail channel. In this section, we change this assumption to that of consumers having no preference for the two channels in R2. Hence, they are uniformly distributed in the two channels, and the demand of the D-C supply chain transforms into the following formation:

$$Q_r = \begin{cases} 1 - \frac{p_r - p_d}{1-\theta} & \text{if } \frac{p_d}{\theta} < p_r \\ \frac{1}{2}\left(1 - \frac{p_d}{\theta}\right) & \text{if } \frac{p_d}{\theta} = p_r \\ 1 - p_r & \text{if } \frac{p_d}{\theta} > p_r \end{cases}, \quad Q_d = \begin{cases} \frac{\theta p_r - p_d}{\theta(1-\theta)} & \text{if } \frac{p_d}{\theta} < p_r \\ \frac{1}{2}\left(1 - \frac{p_d}{\theta}\right) & \text{if } \frac{p_d}{\theta} = p_r \\ 0 & \text{if } \frac{p_d}{\theta} > p_r \end{cases}. \tag{10}$$

The above demand function can eliminate the negative influence of the income separation factor δ on R2. In addition, we take the assumption that the acceptability of the direct channel and the retail channel to consumers is different, thus we use an acceptance parameter θ. However, along with the internet popularization and the progress of science and technology, the direct sales channel can promote consumers' experience of the products from multiple angles. Then, the acceptability of the direct sales channel is gradually increasing, thus θ can be very close to 1. Here, we change the basic assumption to that of the acceptability of the two channels being the same, i.e., $\theta = 1$. In this case, the pricing decisions of the two channels satisfy $p_r = p_d$, so that both channels can generate a sales volume to meet the desire of income separation from the mental accounting of the supplier.

4. Numerical Analysis

We use the method of numerical analysis to show the relationship between the fairness parameter and the scale parameter (α vs. μ graph). We illustrate the equilibrium locations according to inequalities (6), (7) and (8). We set $c_r = 0.3$ and vary the direct channel acceptance parameter θ from 0.7, 0.8 to 0.9, as shown in Figs. 2, 3, and 4.

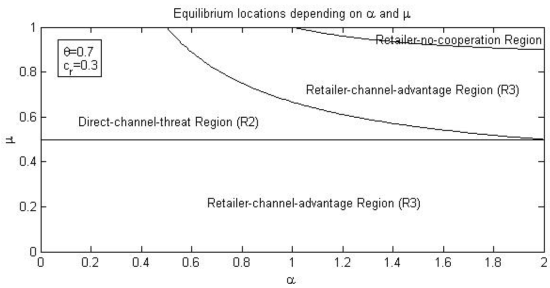

Fig. 2. Relationship of α and μ in case I

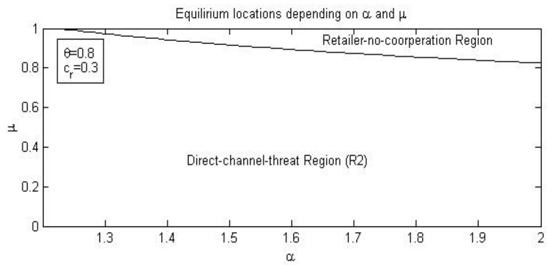

Fig. 3. Relationship of α and μ in case II

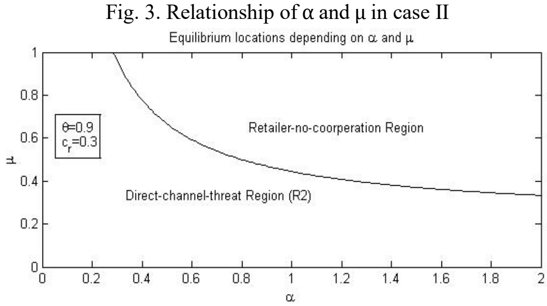

Fig. 4. Relationship of α and μ in case III

The smaller the value of θ is, the bigger the critical value of α will be and the more fairness the retailer can ask for. It makes sense in accordance with common sense. The smaller the consumers' acceptance of a direct channel is, the smaller the threat of a direct channel for the retailer is, thus the retailer has a more advantageous position and they can request more fairness. However, in different categories, if the optimal solution is in R3, the relationship between α and μ will not be affected by the value of θ. If the optimal solution is in R2, θ will influence the critical value of α by affecting the value of μ_2. The larger the μ_2 is, the greater the critical value of α will be.

In a particular case, when the value of θ is quite small, i.e., the acceptability of a direct channel to consumers is quite small, the retailer can ask for more fairness. However, in different cases, if the optimal solution is in R3, as shown in Fig. 2, the relationship between α and μ is not affected by the value of θ. However, if the optimal solution is in R2, as shown in Fig. 3 and Fig. 4, the parameter θ influences the critical value of α.

5. Conclusion

In the pricing decision of the D-C supply chain game, it is unfavorable for retailers to consider fairness. When consumers have high acceptance of direct-channel products, the retailer's requirement for fairness will not harm the supplier's interests. Although the retailer feels unfair and refuses to cooperate with the supplier by sacrificing his own interests, the supplier can get benefits from the direct sales channel, thus there is no need for the supplier to take into account the fairness concern of the retailer. However, when consumers are less receptive to the direct sales channel, the retailer's requirement for fairness will reduce the overall income as well as his own income. Because the acceptance of direct channel products to consumers is low, opening a direct sales channel will not be a deterrent for the retailer, and the traditional retail channel is still in a dominant position. In this case, although the retailer's fairness concern is irrational and it will harm the interests of both sides, the supplier still needs to indulge the retailer's fairness requirement. In conclusion, the retailer should consider whether to sacrifice his income for "fairness" or to negotiate with the supplier for the channel coordination and cooperation when the retail channel is in a dominant position.

When considering the factor of mental accounting, the motivation for the supplier to open a direct sales channel to deter the retailer will be reduced. After opening the direct sales channel, for the supplier, there is still only one channel generating profits. In this case, mental accounting behavior will cause the supplier to be unsatisfied. When the income separation parameter decreases, the motivation for the supplier to open up a direct sales channel can disappear completely, and the supplier will devote to cooperate with the retailer. Furthermore, if the basic assumptions changed, the negative effects of the income separation from the mental accounting of the supplier may be weakened and even eliminated.

We follow the hypothesis of Chiang et al. (2003) that all consumers have a positive preference for the traditional retail channels. Thus, in the critical area R2, all consumers will choose to buy products from the retail channels. However, in fact, consumers' preference for channels is not necessarily the same, which may lead to different conclusions of the supplier's mental accounting model. For future study, it is an interesting topic to study the comparison of the game equilibrium solutions under different assumptions.

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References

[1] Cui, T. H., Raju, J. S., Zhang, Z. J. Fairness and channel coordination. Management Science, 2007, 53(8), 1303-1314.

[2] Dumrongsiri A, Fan M, Jain A, et al. A supply chain model with direct and retail channels. European Journal of Operational Research, 2008, 187(3):691-718.

[3] D Xie, H Chen. Coordination dual-channel supply chain under price mechanism with production cost disruption. Management Science & Engineering, 2015,9(2).

[4] Fehr E, Schmidt K. A theory of fairness, competition, and cooperation. Quarterly Journal of Economics,1999.114(3):817-868.

[5] Kahneman D, Tversky A. Prospect theory: An analysis of decision under risk. Econometrica, 1990, 47(2):140-170.

[6] Li S, Zhang Z. Pricing strategy in risk-averse dual-channel supply chain. Advances in Information Sciences & Service Sciences, 2012, 4(5):78-87.

[7] Li B, Chen P, Li Q, et al. Dual-channel supply chain pricing decisions with a risk-averse retailer. International Journal of Production Research, 2014, 52(52):7132-7147.

[8] Li Q, Li B, Chen P, et al. Dual-channel supply chain decisions under asymmetric information with a risk-averse retailer. Annals of Operations Research, 2015:1-25.

[9] Park S Y, Keh H T. Modelling hybrid distribution channels: A game-theoretic analysis. Journal of Retailing & Consumer Services, 2003, 10(3):155-167.

[10] Thaler Richard. Mental accounting and consumer choice. Marketing Science,1985, 4(3): 199-214.

[11] Wei-yu Kevin Chiang, Dilip Chhajed, James D. Hess. Direct Marketing, Indirect Profits: A strategic analysis of dual-channel supply-chain design. Management Science, 2003, 49(1): 1-20.

[12] Yue X, Liu J. Demand forecast sharing in a dual-channel supply chain. European Journal of Operational Research, 2006, 174(1):646-667.

[13] Zhan Bu, Huijia Li, Jie Cao, et al. Game theory based emotional evolution analysis for Chinese online reviews. Knowledge-Based Systems, 2016, 103, 60-72.