Pricing Strategy for the Dual-channel Supply Chain with Altruism Behavior and Channel Preference

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Abstract

Aiming at the dual-channel supply chain with the manufacturer owned direct channel and retail channel simultaneously, the consumers are divided into retail store loyalty and brand loyalty two parts, under the condition of altruism behavior and the consumers’ channel preference, we studied to the pricing game between the manufacture and retailer. The research result showed that the Nash equilibrium of price exists in centralized and decentralized supply chain system without altruism behavior, the channel preference degree of consumers, the number of retail store loyally consumers are all have certain influence on supply chain’s optimal pricing strategy; under the condition of altruism behavior, the manufacturer and the retailer’s altruism behavior, the channel preference degree of consumers, the number of retail channel loyalty consumers are all have certain influence on supply chain’s optimal pricing strategy, and the influence of manufacture’s altruism behavior on supply chain’s optimal pricing strategy is larger than that of retailer. The numerical experiment has showed the effectiveness of conclusions.

Key words: Altruism behaviour, channel preference, supply chain, pricing strategy

1. INTRODUCTION

With the rapid development of information technology and electronic commerce, more and more consumers shopping by internet channel, according to the latest research result of China Internet Network Information Centre, up to the end December, 2014, the netizen scale of China has reached 649 million, the online shopping scale has reached 361 million, the online shopping rate has improved 55.7%. To satisfy the consumers’ online shopping demand, many enterprises opened internet channel on the base of original retail channel. But the introducing of internet direct channel also gives rise to the benefit game and channel conflict between manufacturer and retailer, and thus lowers the supply chain’s efficiency. Webb pointed out that pricing is the primary factor of causing channel conflict, so the study of pricing strategy is an important issue of dual-channel supply chain (Yun, 2013; Cao, 2014; Zhang, 2014).

Altruistic behaviour is a behaviour characteristic of caring about others welfare, it first originate from ethics, in behaviour operation field, it mainly refers to that the relationship of the behaviour makers is not the pure competitive relation, it is a kind of behaviour characteristics which not only considering its own interest but also other members’ interests. This altruistic behaviour is also widely existed in supply chain’s enterprises, for example, “IBM China Channel University”, it is established by IBM, and used for sharing the latest technology and managerial experience with its channel partners; as the PC manufacturing enterprise, Lenovo once helped its distributor-Teng Chuang Technology to financing. In the dual-channel supply chain, as the manufacturer entered into the sales field of retailer, the relation between the manufacturer and retailer is more complex than the two-stage supply chain model composed by the single manufacturer and retailer. As the upstream enterprise, the manufacturer not only considers its revenue, at the same time, due to it has entered into the retail channel, it is necessary to consider the down-stream retail terminal’s sales and earnings state. As for the retailer, the whole retail terminal’s earnings is composed of itself and the manufacturer’s internet direct channel earnings, its decision-making process will inevitably take the performance of manufacture in retail terminal into account. This complicated relationship is exactly similar to the behaviour characteristics of altruism attribute. So we introduced the altruism behaviour in this paper, and analyzed the decision-makers’ strategy behaviour by the utility function with altruism attribute.

Specific to the study of altruism behaviour, Ge Zehui et al (2012) built an evolution decision model to analyze the altruism attribute of supply network, it indicated that taking altruism attribute into account is beneficial to manufacturer and supply chain system. Disney and Hosoda (2009) took the two-stage supply chain model with first-order autoregressive demand as research objects, and analyzed the influence of the retailer’s altruism attribute on the replenishment strategy, the researches showed that the supply chain’s efficiency with altruism attribute is apparently higher than that of without altruism attribute. Shi Kuiran et al (2013) studied the
two channel structures that manufacturer and retailer set up the electronic channel respectively, it indicated that altruism attribute has influence on the dual-channel supply chain’s pricing strategy, the high of one decision-maker’s altruism attribute, the better for another decision-maker, and the influence of manufacturer’s altruism attribute on pricing strategy is more clear than that of retailer. Han Jiaojie et al (2013) introduced the altruism attribute into the project member’s behaviour decision model by the way of game theory, and studied the influence of altruism preference on member strategies and team performance, the researches showed that altruism attribute have positive effect on the cooperation with other members and team performance. But the above mentioned literatures left the consumers’ channel preference behaviour out of consideration.

Presently, there are some research results on the consumers’ channel preference. Wang Weiguang et al (2013) studied the dual-channel supply chain’s pricing and coordination problem on the base of considering consumers’ channel preference. Wang Zhihong et al (2011) studied the manufacturer’s pricing and channel’s design and selection when the market demand is related to consumers’ channel preference. Moutaz Khouja et al (2010) studied manufacturer’s channel selection and pricing problem on the condition of channel preference has influence on demand. Li Li et al (2013) studied the dual-channel supply chain’s inventory policy on the premise of consumers’ channel preference. However, they haven’t considered the manufacturer and retailer’s altruism behaviour.

Unlike the above mentioned studies, the paper considered the more careful consumers’ segment market model, a portion of consumers only buy products from the traditional retail channel, considers both the manufacturer and retailer’s altruism behaviour, and studies the dual-channel supply chain’s pricing strategy on the condition of altruism behaviour and the consumers’ channel preference.

2. MODEL DESCRIPTION

Aiming at the dual-channel supply chain system composed of one manufacturer and one retailer, and sells a single product, the consumers in the market are divided into the retail channel loyalty and brand loyalty two parts, the consumers of retail channel loyalty only buy products from the traditional retail channel, while the consumers of brand loyalty will consider buy products from either electronic channel or retail channel (see Figure 1). $p_r$ is the retail price in the retail channel, $p_d$ is the direct sale price in the online channel, the manufacturer’s unit wholesale price to retailer is $w$, the number of retail store loyalty consumers is $\alpha_r$, the number of band loyalty consumers is $\alpha_m$, the manufacturer’s unit product cost sailed by the retail channel is $r_c$, and the unit product cost sailed by the electronic channel is $d_c$.

![Figure 1 The dual-channel supply chain model](image)

As the product presented by electronic channel is the virtual product described by way of text, image, and consumers can not evaluate the product correctly by the five sense organs, so it easily leads to the wrong purchasing behaviour, and after buy the product, generally, consumers can not get the whole refund. So the utility value of virtual product in the online channel is less than that of the physical product in the retail store. The consumers’ acceptability to the product of electronic channel is denoted by $\theta$ ($0 \leq \theta \leq 1$) in this paper, if the value of a product in retail channel is $v$, then its value in electronic channel is $\theta v$, the loss of product’s utility in electronic channel is $(1-\theta)v$, the large $\theta$, the higher of consumers’ acceptability to electronic channel, and the smaller of product’s utility loss in electronic channel. For the sake of argument, it assumed that consumers’ willingness to pay the product $v = U(0,1)$, and $\alpha_r + \alpha_m = 1$.

3. MODEL CONSTRUCTION
In the dual-channel supply chain system, to the consumers of retail store loyalty, as long as the surplus value is greater than 0, the consumers will select to buy the product in retail store, so the demand function of retail store loyalty consumers is determined by

\[ Q_{r1} = \begin{cases} \alpha_c (1 - p_r), & 0 \leq p_r < 1 \\ 0, & \text{elsewhere} \end{cases} \tag{1} \]

As for the consumers of brand loyalty, they will possibly buy product from any one channel. Channel preference depends on the ratio of surplus value between retail and electronic channel, namely \((v_r - p_r) / (\theta v - p_d)\). Concretely speaking, when \(v_r - p_r > 0\), all the consumers of brand loyalty will consider buying products from retail channel, when \(v_r = p_r\), there is no difference to consumers whether buy the product from retail channel. When \(\theta v - p_d > 0\), all the consumers of brand loyalty will consider buying products from electronic channel, when \(v_d = p_d / \theta\), there is no difference to consumers whether buy the product from electronic channel. Finally, when \(v_r - p_r = \theta v - p_d\), all the consumers of brand loyalty will prefer to retail channel, and select to buy products from retail channel, when \(v_r - p_r = \theta v - p_d\), that is to say, \(v_d = p_d / \theta\), the two channels have no difference to consumers.

When \(v_d < v'\), namely, \(\frac{p_d}{\theta} < p_r\), we obtained \(v_d - v' = \frac{p_r - p_d}{1 - \theta} - p_r = \frac{\theta p_r - p_d}{1 - \theta} > 0\), so we have \(v_d < v' < v'\). So if the consumers’ willingness to pay the product in \([v_d, v']\), the consumers will select to buy products from electronic channel, if the consumers’ willingness to pay the product in \([v', 1]\), the consumers will select to buy products from retail channel, if the consumers’ willingness to pay the product in \([0, v']\), the consumers will not select to buy products.

When \(v_d > v'\), that is to say, \(\frac{p_d}{\theta} > p_r\), we obtained \(v_d - v' = \frac{p_r - p_d}{1 - \theta} - p_r = \frac{\theta p_r - p_d}{1 - \theta} < 0\), so we have \(v_d > v' > v'\). So if the consumers’ willingness to pay the product in \([v', 1]\), the consumers will select to buy products from retail channel, if the consumers’ willingness to pay the product in \([0, v']\), the consumers will not select to buy products.

So we can obtain the demand functions \(Q_{r2}\) in retail channel and \(Q_d\) in electronic channel of brand loyalty consumers are

\[ Q_{r2} = \begin{cases} \alpha_c (1 - \frac{p_r - p_d}{1 - \theta}), & \frac{p_d}{\theta} < p_r \\ 0, & \text{elsewhere} \end{cases} \tag{2} \]

\[ Q_d = \begin{cases} \alpha_r \frac{\theta p_r - p_d}{\theta (1 - \theta)}, & \frac{p_d}{\theta} < p_r \\ 0, & \text{elsewhere} \end{cases} \tag{3} \]

respectively.

4. ICING STRATEGY OF DUAL-CHANNEL SUPPLY CHAIN WITHOUT ALTRUISM BEHAVIOUR

To comparison conveniently, firstly we study the pricing strategy of centralized and decentralized supply chain without altruism behaviour.

4.1 The centralized supply chain

In the centralized dual-channel supply chain, its profit function \(\pi_c\) is determined by

\[ \pi_c = (p_r - c_r) (Q_{r1} + Q_{r2}) + (p_d - c_d) Q_d \tag{4} \]
Analysing the dual-channel supply chain’s profit function, we have the following theorem.

**Theorem 1** In the centralized dual-channel supply chain when the consumers’ channel preference is considered, the supply chain’s optimal pricing strategy is

\[ p_m^* = \frac{1 + c_r}{2}, \]  
\[ p_a^* = \frac{\theta + c_t}{2}. \]  

**Proof:** Substituting (1), (2) and (3) into (4), and find the second-order partial derivative to \( p_d \), we obtained

\[ \frac{\partial^2 \pi}{\partial p_d^2} = \frac{2\alpha_m}{\theta(\theta - 1)} < 0, \]

as its Hessian matrix

\[ |A| = \begin{vmatrix} \frac{\partial^2 \pi_m}{\partial p_m^2} & \frac{\partial^2 \pi_m}{\partial p_m \partial p_a} \\ \frac{\partial^2 \pi_m}{\partial p_m \partial p_a} & \frac{\partial^2 \pi_m}{\partial p_a^2} \end{vmatrix} = \begin{vmatrix} \frac{2\alpha_m}{\theta(\theta - 1)} & -\frac{2\alpha_m}{\theta - 1} \\ -\frac{2\alpha_m}{\theta - 1} & \frac{2\alpha_m}{\theta - 1} - 2\alpha_r \end{vmatrix} \]

\[ = \frac{4\alpha_m}{\theta(1 - \theta)} > 0, \]

so there exist the optimal solution to \( \pi_r \), and by \( \frac{\partial \pi}{\partial p_a} = 0, \frac{\partial \pi}{\partial p_r} = 0 \) hold.

Then the total profit of supply chain is

\[ \pi_r = 1 + \alpha_r c_r^2 - \frac{c_r}{2} + \frac{\alpha_m c_t^2}{4\theta} + \frac{\alpha_r (c_d - c_t)^2}{4(1 - \theta)}, \]  
\[ \pi_c = \frac{4\alpha_m}{\theta(1 - \theta)} > 0, \]

as the Hessian matrix of the profit function is positive definite.

**Property 1** In the centralized dual-channel supply chain, the pricing of traditional retail channel is proportion to the cost of traditional channel, and the pricing of electronic channel is proportion to the cost of electronic channel and the consumers’ acceptability to the product of electronic channel.

4.2. The decentralized supply chain

In the decentralized dual-channel supply chain, the manufacturer and retailer maximize their own profits independently, this paper models the decision as a sequential, Stackelberg game, with the manufacturer as the leader and the retailer as the follower, then the manufacturer and retailer’s profits are

\[ \pi_m = (w - c_r)(Q_1 + Q_2) + (p_d - c_t)Q_d, \]  
\[ \pi_r = (p_r - w)(Q_1 + Q_2) \]  

respectively.

Analysing the manufacturer and retailer’s profit functions, we have the following theorem.

**Theorem 2** In the decentralized dual-channel supply chain when the consumers’ channel preference is considered, the supply chain’s optimal pricing strategy is

\[ w^* = \frac{1 + c_r}{2}, \]
\[ p_d^* = \frac{c_t + \theta}{2}, \]
\[ p_r^* = \frac{3c_r + c_t - (2\alpha_r + 1)\theta - \alpha_r (c_d - c_t)}{4(1 - \alpha_r \theta)}. \]  

**Proof:** We solve the Stackelberg equilibrium solution of supply chain by inverse order method, firstly, given the manufacturer’s direct channel price \( p_d \) and the wholesale price \( w \), as \( \frac{\partial^2 \pi}{\partial p_d^2} = \frac{2\alpha_m}{\theta - 1} - 2\alpha_r < 0 \), then

\[ \frac{\partial \pi}{\partial p_d} = 0 \]

there exist the optimal solution to \( \pi_r \), and by \( \frac{\partial \pi}{\partial p_r} = 0 \), we obtained

\[ p_r = \frac{1 + p_d + w - \theta - \alpha_r (p_d + w\theta)}{2(1 - \alpha_r \theta)}. \]  

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Substituting (13) into (8), and find the second-order partial derivative to \( p_d \), we obtained \( \frac{\partial^2 \pi_m}{\partial p_d^2} \), as its Hessian matrix

\[
|A| = \begin{bmatrix}
\frac{\partial^2 \pi_m}{\partial p_d^2} & \frac{\partial^2 \pi_m}{\partial p_d \partial w} \\
\frac{\partial^2 \pi_m}{\partial w \partial p_d} & \frac{\partial^2 \pi_m}{\partial w^2}
\end{bmatrix} = \begin{bmatrix}
\frac{\alpha_m(\alpha, 1 - 2\theta(1 - \theta)(1 - \theta\alpha_c))}{\theta - 1} & \frac{\alpha_{-1}}{\theta - 1} \\
\frac{\alpha_{-1}}{\theta - 1} & \frac{1 - \alpha, \theta}{\theta - 1}
\end{bmatrix}
\]

so there exist the optimal solution to \( \pi_m^* \), and by

\[
\begin{align*}
\frac{\partial \pi_m}{\partial p_d} &= 0 \\
\frac{\partial \pi_m}{\partial w} &= 0
\end{align*}
\]

we have (10) and (11) hold. And Substituting (10), (11) into (13), then we obtained (12).

Then the profit of manufacturer and retailer in supply chain is

\[
\pi_m^* = \frac{\alpha, c_2^2 - 1 + 2\alpha, (1 - c_2)}{8\alpha,} + \frac{\alpha_m(c_d - c_2)^2}{8(1 - \theta)} + \frac{\alpha_{-1}c_d^2}{4\theta}
\]

\[
\pi_r = \frac{(1 + \alpha, c, \theta + c_2 - c_1 - \theta - \alpha, c_d)^2}{16(1 - \alpha, \theta)(1 - \theta)}
\]

respectively.

To analyze the decentralized dual-channel supply chain’s optimal pricing strategy, we have the following conclusions.

**Property 2** In the decentralized dual-channel supply chain, the pricing strategy of manufacturer is in accordance with that of centralized dual-channel supply chain, while the optimal pricing of retailer has increased, the amount of increase is

\[
\frac{\alpha_m(c_d - c_2)^2}{8\alpha,} + \frac{\alpha_{-1}c_d^2}{4\theta}
\]

which aggravates the price double marginalization to some extent.

**Property 3** In the decentralized dual-channel supply chain, although the optimal pricing of retailer has increased, the total profit of supply chain has decreased compared with the centralized supply chain, the amount of decrease is

\[
\frac{(1 + \alpha, c, \theta + c_2 - c_1 - \theta - \alpha, c_d)^2}{16(1 - \alpha, \theta)(1 - \theta)}
\]

of decrease. The price double marginalization leads to the profit loss of supply chain.

5. **THE PRICING STRATEGY OF DUAL-CHANNEL SUPPLY CHAIN WITH ALTRUISM BEHAVIOUR**

Under the condition of altruism behaviour, the retailer’s utility function is

\[
U_r = \pi_r + \eta_r\pi_m^*
\]

Where \( \eta_r \in [0, 1] \) denotes the altruism preference degree of retailer to manufacturer, if \( \eta_r = 0 \), it denotes the retailer and manufacturer are perfect competition, if \( \eta_r = 1 \) it denotes the retailer and manufacturer are perfect cooperation, the greater of \( \eta_r \), the greater of retailer’s altruism behaviour to manufacturer.

Similarly, the manufacturer’s utility function is determined by

\[
U_m = \pi_m^* + \eta_m\pi_r
\]

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Where $\eta_m \in [0, 1]$ denotes the altruism preference degree of manufacturer to retailer, if $\eta_m = 0$, it denotes the retailer and manufacturer are perfect competition, if $\eta_m = 1$ it denotes the retailer and manufacturer are perfect cooperation, the greater of $\eta_m$, the greater of manufacturer’s altruism behaviour to retailer.

Analyze the manufacturer and retailer’s profit functions in supply chain, we have the following theorem.

**Theorem 3** In the centralized dual-channel supply chain when the channel preference and altruism behaviour are considered, the supply chain’s optimal pricing strategy is determined by

$$p_{Ad}^* = \frac{\theta + c_d}{2} \tag{18}$$

$$w_{rA}^* = \eta_m^2(2c_r - c_d) + \theta\alpha_m + \alpha_m(c_d - 2c_r, \theta) + \frac{(1 + \alpha_r)\theta + \alpha_r c_d - 2}{2(1 - \alpha, \theta)(\eta_m^2 - 1)} \left[ c_d - c_r - \theta - \alpha_r c_d + \alpha_m c_r, \theta + 1 \right] + \frac{(1 - \alpha, \theta)(\eta_m^2 - 1)\left[ \eta_m (\eta_m^2 + 1) - 2 \right]}{2(1 - \alpha, \theta)(\eta_m^2 - 1)} \left[ \eta_m (1 + \alpha_r)\theta - \alpha_r c_d - 2 \right] \eta_m (1 - \alpha, \theta)(1 + c_r) + 2(1 - \alpha, \theta)(\eta_m - \eta_m \eta_r) \tag{19}$$

**Proof:** We solve the Stackelberg equilibrium solution of supply chain by inverse order method, firstly, given the manufacturer’s direct channel price $p_d$ and the wholesale price $w$, as

$$\frac{\partial^2 U_r}{\partial p_r^2} = \frac{-2\alpha_r}{1 - \theta} < 0,$$

then there exist the optimal solution to $U_r$, and by

$$\frac{\partial U_r}{\partial p_r} = 0,$$

we obtained

$$p_r = \frac{\theta c_r (c_r - w) + \theta c_r + 1 + \alpha_m p_d - 1 + \alpha_r p_r}{\alpha_m (1 - \alpha, \theta)} \tag{20}.$$

Substituting (20) into (17), then we have

$$\frac{\partial^2 U_m}{\partial p_d^2} = \frac{-2\alpha_m}{\theta} + \frac{\alpha_m}{\theta} \left[ (1 + \eta_m)(2 + \eta_m - \eta_m \eta_m) - 2 \right] \left[ \eta_m (\eta_m + 1) - 2 \right] \frac{1}{2(1 - \alpha, \theta)} < 0,$$

so there exist the optimal solution to $\pi_m$, and by

$$\frac{\partial U_m}{\partial p_d} = 0,$$

we have (18) and (19) hold.

And Substituting (18), (19) into (20), then we obtained (20).

Analyze the decentralized dual-channel supply chain’s optimal pricing strategy, we have the following conclusions.
Property 4 To the decentralized dual-channel supply chain when the channel preference and altruism behaviour are considered, the pricing strategy of manufacturer increased with the increasing of $\theta$, but the manufacturer’s wholesale price to retailer and the optimal pricing of retailer decreased with the increasing of $\theta$.

Property 5 To the decentralized dual-channel supply chain when the channel preference and altruism behaviour are considered, the number of retail store loyalty consumers $\alpha_r$ has no influence on the optimal pricing of electronic channel, but the manufacturer’s wholesale price to retailer and the optimal pricing of retailer increased with the increasing of $\alpha_r$.

Property 6 To the decentralized dual-channel supply chain when the channel preference and altruism behaviour are considered, the manufacturer and retailer’s altruism behaviour have no influence on the optimal pricing of electronic channel, but has influence on the manufacturer’s wholesale price to retailer and the optimal pricing of retailer, and the influence of manufacturer’s altruism behaviour on supply chain’s pricing strategy is greater than that of retailer, the manufacturer’s wholesale price to retailer and the optimal pricing of retailer increase with the increasing of retailer’s altruism behaviour, the manufacturer’s wholesale price to retailer and the optimal pricing of retailer decrease with the increasing of manufacturer’s altruism behaviour.

6. NUMERICAL EXAMPLES

In section 3, 4 and 5, we obtained the pricing strategy of supply chain by theoretical analytical method, this section we perform a numerical analysis to verify our results and analysis the relationship between decision variable, objective function and the relevant parameters. It will complement analytical results and provide us with more managerial insights.

In our example, the parameters in the supply chain system take in the following values:

$$\alpha_r = 0.3, c_r = 0.3, c_d = 0.2, \theta = 0.5, \eta_r = 0.5, \eta_m = 0.5.$$ 

In the dual-channel supply chain without altruism behavior, the influence of consumers’ channel preference to electronic channel, the number of retail store loyalty consumers on the optimal pricing of manufacturer and retailer is as Figure 2 and Figure 3, they are agree with Property 1 and Property 2.

Figure 2 The influence of $\theta$ on the supply chain’s optimal pricing without altruism behaviour

Figure 3 The influence of $\alpha_r$ on the supply chain’s optimal pricing without altruism behaviour

It can be seen from Figure 2 that in the decentralized supply chain, the manufacturer’s optimal pricing raised with the increasing of consumers’ acceptance level to electronic channel, while the retailer declines its optimal pricing in order to attract the more consumers, as the wholesale price of manufacturer to retailer remains
unchanged, it leads to the retailer’s benefit lost. In the centralized supply chain, with the increasing of consumers’ acceptance level to electronic channel, the manufacturer raised the price of the electronic channel, but the retail channel’s price remained unchanged, so the supply chain obtained the more benefits.

It can be seen from Figure 3 that in the decentralized supply chain, with the increasing of the number of retail store loyalty consumers $\alpha_r$, the retailer increased its optimal pricing, while the wholesale price of manufacturer to retailer and the price of the electronic channel remain unchanged; it leads to the retailer’s benefit increase. In the centralized supply chain, the manufacturer and the retailer are joint decision making, so their optimal pricing have not changed with the number of retail store loyalty consumers $\alpha_r$.

When both the manufacturer and retailer’s altruism behaviour and consumers’ channel preference are considered, the influence of manufacturer and retailer’s altruism behaviour to electronic channel, the consumers’ channel preference on the manufacturer and retailer’s optimal pricing in the decentralized supply chain is as Figure 4 to Figure 7.

![Figure 4](image1)

**Figure 4** The influence of $\eta$ on the supply chain’s optimal pricing with altruism behaviour

![Figure 5](image2)

**Figure 5** The influence of $\alpha_r$ on the supply chain’s optimal pricing with altruism behaviour

It can be seen from Figure 4 and Figure 5 that the manufacturer and retailer’s altruism behaviour have no influence on the pricing of electronic channel, the retailer’s optimal pricing increased with the increasing of retailer’s altruism behaviour, but the increase is modest, while the manufacturer’s wholesale price to retailer is growing quickly with the increasing of retailer’s altruism behaviour, with the help of retailer’s altruism behaviour, the manufacturer obtained the more profits by raising the
The influence of $\theta$ on the supply chain’s optimal pricing with altruism behaviour

wholesale price. The retailer’s optimal pricing decreased with the increasing of manufacturer’s altruism behaviour, but the decrease is modest, while the manufacturer’s wholesale price to retailer drops sharply with the increasing of manufacturer’s altruism behaviour, with the help of manufacturer’s altruism behaviour, the retailer obtained the more profits by raising the price difference of unit product.

It is observed from Figure 6 that when both the manufacturer and retailer’s altruism behaviour and consumers’ channel preference are considered, the consumers’ acceptance level to electronic channel has influence on the supply chain’s pricing, the manufacturer’s wholesale price to retailer decreased with the increasing of consumers’ acceptance level to electronic channel, thus the manufacturer reduced the retailer’s profit loss. The retailer’s optimal pricing decreased with the increasing of consumers’ acceptance level to electronic channel, but the decreased magnitude has declined compared with the condition of without altruism, the manufacturer’s optimal pricing increased with the increasing of consumers’ acceptance level to electronic channel, but the increased magnitude has declined compared with the condition of without altruism.

Figure 7 The influence of $\alpha$ on the supply chain’s optimal pricing with altruism behaviour

From Figure 7 we can see that when both the manufacturer and retailer’s altruism behaviour and consumers’ channel preference are considered, the number of retail store loyalty consumers has influence on the retailer’s optimal pricing and the wholesale price of manufacturer to retailer, the retailer’s optimal pricing increased with the increasing of the number of retail store loyalty consumers, but the increase magnitude has declined compared with the condition of without altruism, the retailer obtained the more profits because of price advantage, the wholesale price of manufacturer to retailer increased with the increasing of the number of retail store loyalty consumers, thus the manufacturer also obtained the more profits by improving wholesale price.

7. CONCLUSIONS

The paper studied the dual-channel supply chain system which are composed of one manufacturer and retailer, and sells a single product, the consumers are divided into retail channel loyalty and brand loyalty two parts, under the condition of altruism behaviour and the consumers’ channel preference, we studied to the pricing strategy of supply chain, and obtained the Stackelberg equilibrium solution of supply chain, the numerical experiment has showed the effectiveness of the conclusions.

There are several directions for further analysis that will achieve a better understanding of dual-channel supply chain. For instance, one may consider introducing the service in dual-channel supply chain, and further discussing the influence of service on pricing strategy, in addition, it would be interesting to examine the pricing strategy of dual-channel supply chain with the manufacturer and retailer’s altruism behaviour and consumers’
channel preference under the condition of asymmetric information, and studied the influence of asymmetric information, consumers’ channel preference and the manufacturer and retailer’s altruism behaviour on supply chain’s pricing strategy.

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