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Buy Back Contract Considering Fairness Preference under the Framework of Nash-Bargain in a Two Stage Supply Chain

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ABSTRACT

This paper using the method of establish models and analysis data mainly research the influence on a two stage supply chain that contains one supplier and one retailer caused by buy back contract considering fairness preference. The research shows that buy back contract can coordinate the supply chain and fairness preference will not affect the coordination of buy back contract. Moreover, the retailer's optimal order quantity will not change as buy back contract concerning fairness preference, but the retailer's optimal order quantity will be increase as the cost increase. The most important finding in this paper is that even when the supplier don't know the retailer's degree of fairness preference, he can also design a wholesale price and a buy-back price to achieve the best profits or utility.

Keywords - *Nash bargaining; Newsvendor model; Buy back contract; Fairness preference; Supply chain coordination*

1. Introduction

Buy back contract is defined as that when the retailer's order quantity is greater than the market demand at the end of the sales season, the supplier will buy back the left products in a price that is less than the wholesale price to incentive the retailer to order more products. To some products whose demand is uncertainty and life cycle is short, the retailer's action of ordering more products will bring him huge losses. Therefore, buy back contract is commonly used in the market. Using buy back contract is beneficial not only to the supplier but also to the retailer in the process of trade (Gilbert 1998; Donohue 2000). When the supplier and the retailer possess asymmetric information, the optimal buy back contract is not always can be reached (Qiang 2008). Whether buy back contract can coordinate the supply chain is studied (Yu 2005; Wang 2008; Liu 2010; Liu 2012). The traditional supply chain research believed that the decision makers are completely rational, and can always make a decision to maximize the interests (Su 2008).However, decision makers are not completely rational and their behavior will be affected by some factor such as fairness preference, loss aversion, sympathy, disgust and so on. People always show great attention to fairness preference (Fehr et al. 1999). Loch (2008) found fairness preference is existed in our daily life through an experimental research. When the parties considering fairness preference, how will it impact on coordination of the supply chain (Demirag 2010; Du et al.2010; Cui et.al 2007; Wei et al. 2011). A new buy back contract for dual channel was designed to coordinate supply chain under the situation of market demand is stochastic and influenced by retailers' sales efforts (Wei et al. 2013).

In conclusion, most of the present articles about supply chain did not consider fairness preference. Even some literatures considered fairness preference, they argued fair is absolutely rather than comparatively, in practice, due to the state, power, and the influence of two sides, they often focused on the comparatively fair. Furthermore, most of the articles were not considered supplier's fairness preference. Based on this, this paper draw the fairness preference into buy back contract, according to the Nash bargaining game, we establish a framework and functions of utility about fairness preference to study the coordination of buy-back contract; we also carry out the sensitivity analysis about wholesale price, retail price, cost and buy back price.

2. The Model

2.1 The Newsvendor Model

Consider a two stage supply chain where the retailer orders products from the supplier at a wholesale price, w and sells the products to customers at a retail price, p. We assume that market demand is D and average demand is μ, $\mu = E(D)$. Also we use $f(\cdot)$ represents probability density function and $F(\cdot)$ represents cumulative distribution function. Respectively, F is a continuous, differentiable and strictly increasing function, also $F(0) = 0$, $\overline{F}(x) = 1 - F(x)$. We suppose c is the supplier's cost to produce a production and b is a buy back price. To assured that the retailer will not get benefit from the gap of a buy back price and a wholesale price, we assumed the buy-back price is smaller than the wholesale price, that is to say $b < w$. From this settings, we can calculated the expectation quantity of

the retailer is $s(q)=\int_0^q \overline{F}(x)dx = q-\int_0^q F(x)dx$.

So the expectation profit of the retailer, the supplier and the system as followed:

$$\pi_r = ps(q)-[(w-b)q+bs(q)] = (p-b)s(q)-(w-b)q$$

$$\pi_s = (w-b)q+bs(q)-cq = bs(q)+(w-b-c)q$$

$$\pi = \pi_r+\pi_s = ps(q)-cq$$

We use q^* and q° represent the optimal quantity of the retailer and the supply chain system. Respectively, the first derivative and second derivative to retailer's profit function are:

$$\frac{d\pi_r}{dq} = (p-b)\overline{F}(q)-(w-b)$$

$$\frac{d^2\pi_r}{dq^2} = -(p-b)f(q) < 0$$

$\pi_r(q)$ is a strictly concave function, and because $\forall \pi(q) \geq 0$, so the retailer's optimal order quantity is the only one solution and the optimal quantity satisfy the situation:

$$\overline{F}(q^*) = \frac{w-b}{p-b}$$

In the similar way, we can gain $\overline{F}(q^\circ) = \frac{c}{p}$

To realize the coordination of supply chain system, we need satisfy the situation $q^* = q^\circ$, it is not difficult to draw out:

$$w = c+(\frac{p-c}{p})b$$

Clearly, as long as wholesale price w established the relationship between with buy back price p, buy back contract can coordinate supply chain system.

2.2 The optimal solution of fairness preference frame under Nash bargaining

In real life, people always show a great attention to fair, many studies suggest that people's decision will be affected by fairness preference, when one party feel he was treated unfairly in a transaction, he would rather lose a portion of interests to punish the other party to realize the fair distribution[16]. Therefore the introduction of fairness preference was significant in buy back contract. However, because fairness is relative, the strength and contribution of the two parties will affect the distribution of interests, so the two sides argued for their own fair profits as a judge of whether the trade is fair or not. Based on this, we introduced the fair solution under Nash barging[17]. λ_r and λ_s means the fairness preference of retailer and supplier, and $\lambda_r \geq 0$, $\lambda_s \geq 0$. $\lambda_r = 0$ means that retailer don't care fair, $\lambda_s = 0$ means supplier don't care fair, and $\overline{\pi}_r+\overline{\pi}_s = \pi$, $\pi_r+\pi_s = \pi$.

The utility function of retailer, supplier and supply chain system are:

$$U_r = \pi_r+\lambda_r(\pi_r-\overline{\pi}_r) = (1+\lambda_r)\pi_r-\lambda_r\overline{\pi}_r$$

$$U_s = \pi_s+\lambda_s(\pi_s-\overline{\pi}_s) = (1+\lambda_s)\pi_s-\lambda_s\overline{\pi}_s$$

$$U = U_r+U_s$$

Based on the Nash bargaining, the solution of the model is:

$$\begin{cases} \max\limits_{\pi_r,\pi_s} U_r U_s \\ \pi_r+\pi_s = \pi \\ U_r, U_s > 0 \end{cases}$$

$$U_r U_s(\pi,\pi_r) = [(1+\lambda_r)\pi_r-\lambda_r\overline{\pi}_r][(1+\lambda_s)(\pi-\pi_r)-\lambda_s(\pi-\overline{\pi}_r)]$$

$$\frac{d^2(U_rU_s)}{d\pi_r^2} = -2(1+\lambda_r)(1+\lambda_s) < 0$$

So it is a strictly concave function, there is only one maximum solution, and satisfy the following conditions:

$$\frac{dU_rU_s(\pi_r^*)}{d\pi_r} = -2(1+\lambda_r)(1+\lambda_s)\pi_r^*+(1+\lambda_r)\pi+(\lambda_r+\lambda_s+2\lambda_r\lambda_s)\overline{\pi}_r = 0$$

According to the fixed point theory, we can figure that $\pi_r^* = \overline{\pi}_r$.

Through simultaneous of the above two equations, we can get further results:

$$\overline{\pi}_r = \frac{1+\lambda_r}{2+\lambda_r+\lambda_s}\pi$$

$$\overline{\pi}_s = \frac{1+\lambda_s}{2+\lambda_s+\lambda_r}\pi$$

2.3 The model concerning fairness preference

2.3.1 Only the retailer considers fairness preference

Proposition 1 when the retailer pays attention to fairness preference, but the supplier does not care fair, buy back contract can coordinate the supply chain, it has nothing to do with fairness preference coefficient, and coordination condition remains the same.

There are some procedures to prove the proposition:

From step 3 and the assume, we know that:

$$\overline{\pi}_r = \frac{1+\lambda_r}{2+\lambda_r}\pi, \quad \overline{\pi}_s = \frac{1}{2+\lambda_r}\pi$$

$$U_r = (1+\lambda_r)\pi_r-\lambda_r\overline{\pi}_r = (1+\lambda_r)\pi_r-\frac{\lambda_r(1+\lambda_r)}{(2+\lambda_r)}\pi$$

$$U_s = \pi_s = \pi-\pi_r$$

$$U = U_r+U_s = \lambda_r\pi_r+\frac{2-\lambda_r^2}{2+\lambda_r}\pi$$

We use the symbol q_r^* and q_r° represent the optimal orders of the retailer and the supply chain under buy back contract.

Through the calculation, we can get the following results:

$$\begin{cases} \frac{d^2U_r}{dq^2} \geq 0, \text{if } \lambda_r \geq \frac{2(p-b)}{b} \\ \frac{d^2U_r}{dq^2} < 0, \text{if } \lambda_r < \frac{2(p-b)}{b} \end{cases}$$

If $\lambda_r \geq \frac{2(p-b)}{b}$, the function, U_r is convex, and maximize the utility of the order should be in two extreme point (0 and supplier's maximum capacity), clearly this product market is very rare in reality. If $\lambda_r < \frac{2(p-b)}{b}$, the function is a strictly concave, there is only one optimal solution, and satisfied the equation:

$$(1+\lambda_r)[(p-b)\bar{F}(q_r^*)-(w-b)]-\frac{\lambda_r(1+\lambda_r)}{2+\lambda_r}(p\bar{F}(q_r^*)-c)=0$$

Simplify the equation, the result is:

$$\bar{F}(q_r^*)=\frac{(\lambda_r+2)(w-b)-\lambda_r c}{2p-(\lambda_r+2)b}$$

In the similar way, we can figured that

$$\bar{F}(q_r^\circ)=\frac{\lambda_r(\lambda_r+2)(w-b)+(2-\lambda_r^2)c}{2(1+\lambda_r)p-\lambda_r(\lambda_r+2)b}$$

If we want to realize the coordination of supply chain system, the equation $q_r^* = q_r^\circ$ should be satisfied. Therefore, we can obtain the following equation:

$$\frac{(\lambda_r+2)(w-b)-\lambda_r c}{2p-(\lambda_r+2)b}=\frac{\lambda_r(\lambda_r+2)(w-b)+(2-\lambda_r^2)c}{2(1+\lambda_r)p-\lambda_r(\lambda_r+2)b}$$

Simply this equation, we can get the result:

$$w=c+(\frac{p-c}{p})b$$

Obviously, when the retailer pays attention to fairness preference, as long as the wholesale price w established the relationship between with the buy-back price p, buy-back contract can coordinate supply chain system.

Inference 1 when the retailer pays attention to fairness preference and buy-back can coordinate the supply chain, we can derived some conclusions as followed:

(1) $q_r^* = q_r^\circ = q* = q\circ$;

(2) λ_r can not affect q_r^*;

(3)as the increase of the retail price p, the cost c, the buy-back price b, the retailer's orders q_r^* will be increased. But as the increase of the wholesale price w, the retailer's orders q_r^* will be decreased.

Proof(1). According to equation $\frac{dU_r}{dq}$, we can know that

$$\frac{dU_r(q*)}{dq}=-\frac{\lambda_r(1+\lambda_r)}{2+\lambda_r}[\frac{p(w-b)}{p-b}-c]=0$$

So $q_r^* = q*$.

In a similar way $q_r^\circ = q*$, $q* = q\circ$.

In summary, $q_r^* = q_r^\circ = q* = q\circ$.

Obviously, when the retailer pays attention to fairness preference, the supplier does not care fair, and buy-back contract can coordinate the supply chain, the order quantity we mentioned is the same. This is because that the condition to coordinate the supply chain is not change.

Proof(2). According to the theory of implicit function, we can obtain the equation $\frac{\partial q_r^*}{\partial \lambda_r}=\frac{\partial^2 U_r(q_r^*)/\partial q\partial\lambda_r}{-\partial^2 U_r(q_r^*)/\partial q^2}=0$.

That is to say the retailer's orders, q_r^* have no connection with the coefficient of retailer' fairness preference, λ_r. This is also because that the condition to coordinate the supply chain is not change.

Proof(3). According to the theory of implicit function, we can obtain the equation

$$\frac{\partial q_r^*}{\partial w}=\frac{\partial^2 U_r(q_r^*)/\partial q\partial w}{-\partial^2 U_r(q_r^*)/\partial q^2}=\frac{-(2+\lambda_r)(1+\lambda_r)}{-[(\lambda_r+1)(\lambda_r+2)b-2(1+\lambda_r)p]f(q)}<0$$

In a similar way, we can get further results as followed:

$$\frac{\partial q_r^*}{\partial p}>0 \quad \frac{\partial q_r^*}{\partial c}>0 \quad \frac{\partial q_r^*}{\partial b}>0$$

Analysis the result, we found when the retailer pays attention to fairness preference the orders will increase as the cost increased. The result is different with the neutral supply chain. That is due to that under a neutral condition, the retailer is only concerned with his own profits, but when he cares fair, retailer also concerned the suplier's profits. So when the cost is increased, the profits of the supply chain are reduced, the retailer feel more fair, the retailer's utility also increased.

2.3.2The retailer and the supplier all pay attention to fairness preference

According to the assume we get the inequation $\lambda_r > 0$ and $\lambda_s > 0$.

Proposition 2 when the supplier and the retailer all care fair at the same time, buy-back contract can achieve coordination, and the condition remain unchanged and it has nothing to do with the coefficient of fairness preference.

Prove: we can calculate the following equation through the frontier context,

$$U_r=(1+\lambda_r)\pi_r-\lambda_r\bar{\pi}_r=(1+\lambda_r)\pi_r-\frac{\lambda_r(1+\lambda_r)}{2+\lambda_r+\lambda_s}\pi$$

$$U_s = (1+\lambda_s)\pi_s - \lambda_s\bar{\pi}_s = (1+\lambda_s)(\pi-\pi_r) - \frac{\lambda_s(1+\lambda_s)}{2+\lambda_s+\lambda_r}\pi$$

$$U = U_r + U_s = (\lambda_r-\lambda_s)\pi_r + \frac{2+2\lambda_s+\lambda_r\lambda_s-{\lambda_r}^2}{2+\lambda_s+\lambda_r}\pi$$

When the retailers and suppliers are all care fair, we use q_{sr}^* and q_{sr}° represent the optimal quantity of the retailer and supply chain system respectively. Use the same produces with proposition 1, we found that

$$\bar{F}(q_{sr}^*) = \frac{(2+\lambda_r+\lambda_s)(w-b)-\lambda_r c}{(2+\lambda_s)p-(2+\lambda_r+\lambda_s)b}$$

$$\bar{F}(q_{sr}^\circ) = \frac{(\lambda_r-\lambda_s)(2+\lambda_r+\lambda_s)(w-b)+(2+2\lambda_s+\lambda_r\lambda_s-{\lambda_r}^2)c}{(2+2\lambda_r+\lambda_r\lambda_s-{\lambda_s}^2)p-(\lambda_r-\lambda_s)(2+\lambda_r+\lambda_s)b}$$

To coordinate the supply chain, $w = c + \frac{b(p-c)}{p}$

So in the case of retailer and supplier are focused on fair, as long as the wholesale price established the relationship between with buy-back price, buy-back contract can coordinate supply chain system.

This equation suggests that if we established such a relationship between the wholesale price and the buy-back price, retailers' fairness preference does not affect the coordination of buy-back contract.

We also found that whether two sides pay attention to fair or not, the condition to coordinate the supply chain is not change, this is because even the retailer cares fair, supply chain system is still can be coordinated, and coordinated condition did not change. In this way, even if the supplier can't get the retailer's attitude toward fairness preference, he can also make decision to maximize his utility.

Inference 2 when the retailer and the supplier all pay attention to fairness preference, and buy-back contract can coordinate the supply chain,

(1) it has nothing to do with fairness preference coefficient;

(2) as the increase of the retail price p, the cost c, the buy-back price b, the retailer's orders q_r^* will be increased. But as the increase of the wholesale price w, the retailer's orders q_r^* will be decreased.

Proof(1). According to the theory of implicit function, we can obtain the equation $\frac{\partial q_{sr}^*}{\partial \lambda_r} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial\lambda_r}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} = 0$ and $\frac{\partial q_{sr}^*}{\partial \lambda_s} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial\lambda_s}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} = 0$.

Proof(2). According to the theory of implicit function, we can obtain the following equation, $\frac{\partial q_{sr}^*}{\partial w} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial w}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} < 0$

$$\frac{\partial q_{sr}^*}{\partial p} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial p}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} > 0$$

$$\frac{\partial q_{sr}^*}{\partial c} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial c}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} > 0$$

$$\frac{\partial q_{sr}^*}{\partial b} = \frac{\partial^2 U_r(q_{sr}^*)/\partial q\partial b}{-\partial^2 U_r(q_{sr}^*)/\partial q^2} > 0$$

These results are same with the condition that when only the retailer cares fair. The reasons we had explained in the frontier context.

3. Data analysis

Assuming that the market demand follow a normal distribution, $D \sim N(2000,100^2)$, $p=150$, $c=30$, $w=70$, $b=50$. According to the equations $\bar{F}(q*) = \frac{w-b}{p-b} = 0.2$ and $\bar{F}(q\circ) = \frac{c}{p} = 0.2$, we can obtain the results $q* = 2084$ and $q\circ = 2084$. The profits of the supply chain system are 235830.

3.1 Only the retailer cares fair

We can get some results from Table 1, the retailer's optimal orders is equal to the orders of supply chain system, even the fairness preference coefficient was changed, the orders also remained the same.

Table 1 the effects to buy-back caused by the retailer's fairness preference

λ_r	q_r^*	$\pi_r(q_r^*)$	$\pi(q_r^*)$	$U_r(q_r^*)$	$U(q_r^*)$
0	2084	157220	235830	157220	235830
0.1	2084	157220	235830	160589	239199
0.2	2084	157220	235830	162937	241547
0.5	2084	157220	235830	165081	243691
0.8	2084	157220	235830	161712	240322
1	2084	157220	235830	157220	235830
1.3	2084	157220	235830	147929	226539
1.6	2084	157220	235830	136257	214867
2	2084	157220	235830	117915	196525
2.5	2084	157220	235830	91711	170321
3	2084	157220	235830	62888	141498
3.5	2084	157220	235830	32158	110768
3.8	2084	157220	235830	13011	91621

To analyze the influence of external parameters on the retailer's optimal order quantity, we carried the sensitivity analysis. When buy-back contract can achieve coordination, we choose different fairness preference in order to make sensitivity analysis more general. Comparing the degree of fairness preference, carve 1 is smaller than carve 2. And in these two cases, we study how the wholesale price, retail price, cost and buy-back price affect the retailer's optimal order quantity. Figure1~4 is show the connection.

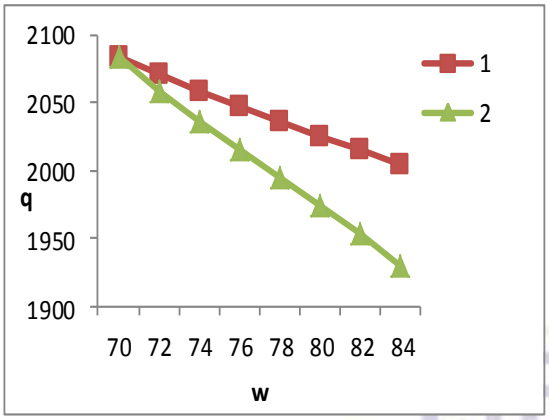

Fig.1 Influence of wholesale price to the retailer's optimal order quantity

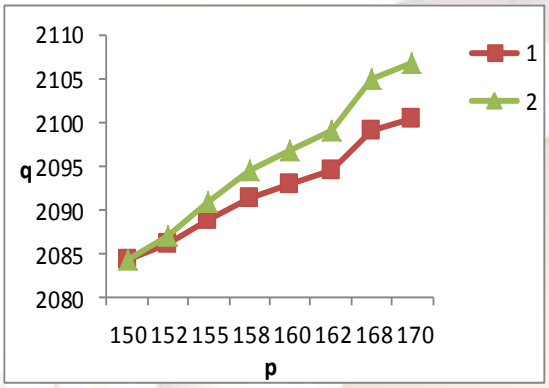

Fig.2 Influence of retail price to the retailer's optimal order quantity

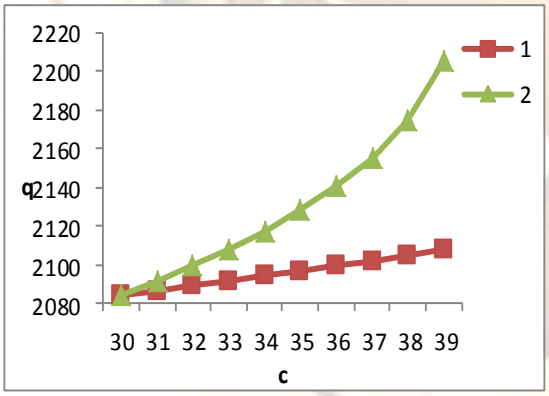

Fig.3 Influence of cost to the retailer's optimal order quantity

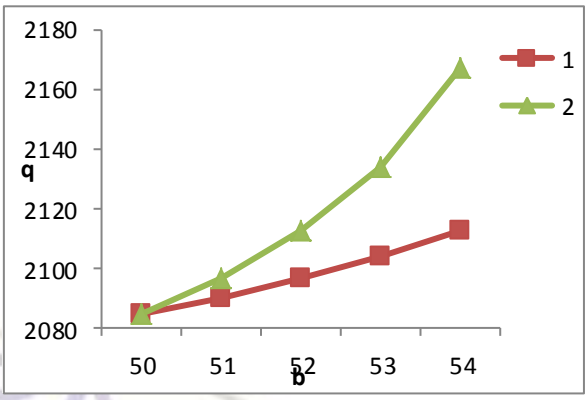

Fig.4 Influence of buy-back price to the retailer's optimal order quantity

Note: about the degree of the retailer's fairness preference, curve 1 is smaller than curve 2. These carve justified the inference 1(3).

3.2 The retailer and the supplier all pay attention to fairness preference

We assume the other parameters remain the same and fix the supplier's fairness preference to study the influence on buy-back contract that caused by the change of the retailer's fairness preference. We can get tab 2 through compute. As can be seen, when the retailer's fairness preference is increasing, the retailer's optimal order quantity is unchanged. The quantity is equal to the orders that the retailer who does not care fair. This showed that the retailer's optimal order quantity is not affected by the retailer's preference coefficient. The retailer's utility is increases first and then decreases; the supply chain's utility is increases first and then decreases.

Table 2 and table 3 have showed that when the retailer and supplier are all concerned about the fairness preference, the retailer's optimal order quantity will not change and is equal to the neutral retailer's optimal order quantity. This conclusion can be used to guide the practice in real life, when buy-back contract can achieve coordination and the two sides pay attention to fairness preference, the retailer's optimal order quantity can be refer to the neutral retailer's order quantity.

Table3 represent the effect of supply chain when the supplier's fairness preference is changed and the retailer's fairness preference is fixed. From the table 3, we can see when the supplier's fairness preference is increase, the retailer's optimal order quantity is unchanged, the optimal order quantity is equal to the orders when the retailer did not care fair. This showed that the retailer's optimal order quantity is not affected by the supplier's preference coefficient. With the increase of supplier's fairness preference coefficient, The retailer's utility is increases and the supply chain's utility is increased first and then decreased.

Table 2 the effects to buy-back caused by the

retailer's fairness preference

λ_r	q_{sr}^*	$U_r(q_{sr}^*)$	$U_s(q_{sr}^*)$	$U(q_{sr}^*)$
0.1	2084	164573	5072	169645
0.2	2084	170976	9827	180803
0.5	2084	185295	22460	207755
0.8	2084	193628	33099	226727
1	2084	196525	39305	235830
1.3	2084	197621	47532	245153
1.6	2084	195499	54685	250184
2	2084	188664	62888	251552
2.5	2084	175085	71464	246549
3	2084	157220	78610	235830
3.5	2084	136055	84657	220712
3.8	2084	122076	87858	209934

Table 3 the effects to buy-back caused by the supplier's fairness preference

λ_s	q_{sr}^*	$U_r(q_{sr}^*)$	$U_s(q_{sr}^*)$	$U(q_{sr}^*)$
0.1	2084	147394	79265	226659
0.2	2084	154033	79035	233068
0.3	2084	160323	77989	238312
0.4	2084	166290	76192	242482
0.5	2084	171959	73697	245656
0.6	2084	177352	70557	247909
0.7	2084	182488	66818	249306
0.8	2084	187384	62523	249907
0.9	2084	192059	57706	249765
1	2084	196525	52407	248932
1.3	2084	208808	33900	242708
1.5	2084	216178	19652	235830
2	2084	232257	-21439	210818

To analyze the influence of external parameters on the retailer's optimal order quantity, we carried the sensitivity analysis. When buy-back contract can achieve coordination, we choose different fairness preference in order to make sensitivity analysis more general. Carve 1 is represents that the retailer's fairness preference is smaller than the supplier's fairness preference. Carve 2 is opposed to carve 1. And in these two cases, we study how the wholesale price, retail price, cost and buy-back price affect the retailer's optimal order quantity. Figure 5~8 are show the connection.

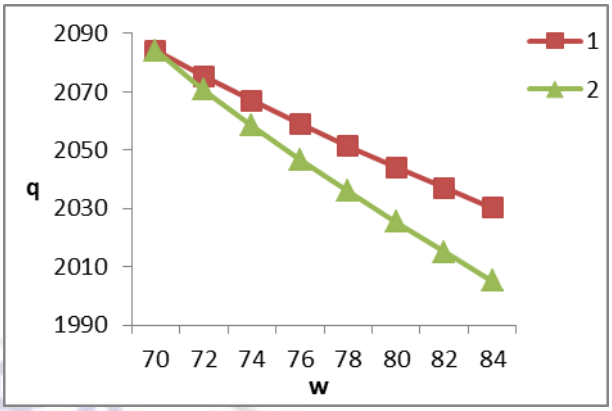

Fig.5 Influence of wholesale price to the retailer's optimal order quantity

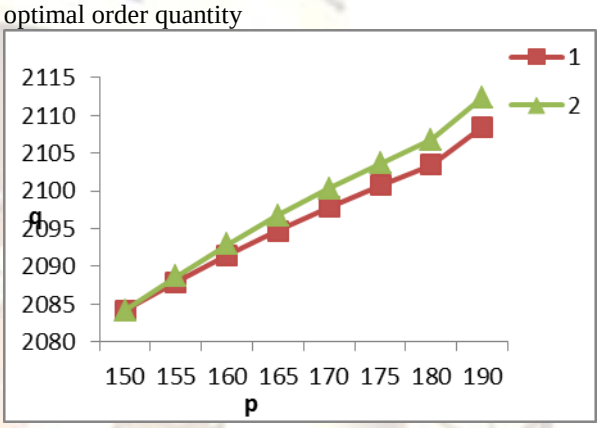

Fig.6 Influence of retail price to the retailer's optimal order quantity

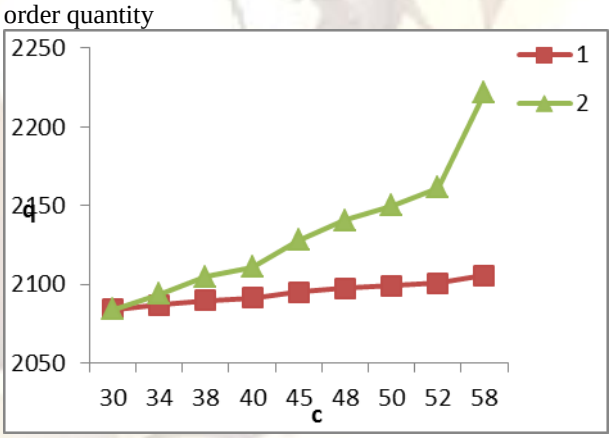

Fig.7 Influence of cost to the retailer's optimal order quantity

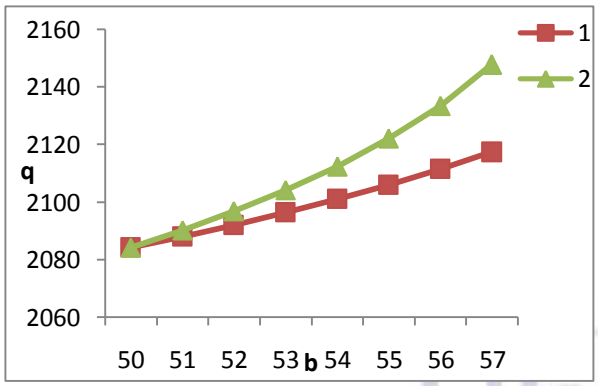

Fig.8 Influence of buy-back price to the retailer's optimal order quantity

Note: Carve 1 is represents that the retailer's fairness preference is smaller than the supplier's fairness preference. Carve 2 is opposed to carve 1.

These carve justified the inference 2(2).

4. Conclusion

This paper based on the newsvendor model, establishing a fairness preference framework according to the Nash barging theory, using the method of constructing model and numerical analysis to study the influence on buy-back contract.

This paper shows that buy-back contract can coordinate the supply chain even the two parties pay attention to fairness preference. That is to say that the fairness preference will not affect the coordination of buy-back contract. When buy-back contract can coordinate the supply chain, the retailer's optimal order quantity is never changed whether the two sides care or not care fair, furthermore we can obtain that even if a supplier doesn't know a retailer's fairness preference degree, he still can make the optimal decision to maximizing his utility through given an appropriate wholesale price and a buy-back price. The retailer's optimal order quantity is decreasing with increasing of the wholesale price and increasing with the increase of retail price or buy-back price. Unlike neutral supply chain, when considered fairness preference, the retailer's optimal order quantity will increase with the increase of cost. That is due to that under a neutral condition, the retailer is only concerned with his own profits, but when he cares fair, retailer also concerned the suplier's profits. So when the cost is increased, the profits of the supply chain are reduced, the retailer feel more fair, the retailer's utility also increased.

However, there are still some limitations in this paper. First, we consider a two-stage supply chain including a retailer and a supplier, in another word, we did not consider the competition and cooperation among supply chain members, therefore future research can be extended the supply chain. Second, we assume the members of the supply chain is focused on fairness preference, but in real life, people will consider a variety of behavior, such as reciprocity, empathy, jealousy, so the future research can be studied from the supply chain members who also consider a variety of behavioral tendency.

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