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Equilibrium Contracting Strategy under Supply Chain to Supply Chain Competition

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Abstract—We consider two competing supply chains, each consisting of one dominant supplier and one retailer. The supplier offers either a consignment contract or a wholesale-price contract. If the retailer accepts the contract, she then decides the stocking level and the retail price of the product. The demand for each product is stochastic and price-sensitive. We show that the equilibrium contract strategy depends on the price sensitivity of the demand and the cost-share rate of the retailer. More specifically, for symmetric supply chains, we observe that consignment contract is the equilibrium strategy of the two supply chains when (1) the retailer’s cost-share rate is large, or (2) the retailer’s cost-share rate and price sensitivities are small; otherwise, wholesale-price contract is the equilibrium strategy of the two supply chains.

I. INTRODUCTION

With the development of global economic integration, the competition is no longer between the companies, but between supply chains. PC vs. Mac supply chains, Fashion apparel (e.g., zara, levi’s) and fast food chains are important consumer product class examples of supply chain competition [1]. As competition becomes more intense, how to control the supply chain inventory has been one of the major problem between suppliers and retailers since a lot of money is tied up in inventory. The inventory management problem in the chain-to-chain competition calls for re-examination of supply chain contracting decisions.

In the vitamin supplement industry, for example, the two largest players, General Nutrition Centers (NYSE: GNC) and Vitamin Shoppe (NYSE: VSI), use different contracts with their exclusive retailers. Drugstore.com has become the exclusive retailer on the Web of GNC brand products since 1999. The two firms keep partnership under consignment contract where the supplier GNC keeps the ownership of the inventory in the warehouse and receives money until the product is sold by Drugstore.com. On the other hand, VSI (a New York corporation) cooperates with it’s only retail website VitaminShoppe.com (a Delaware corporation) under wholesale-price contract where VitaminShoppe.com purchases its requirements for vitamins, supplements, minerals and other products from VSI, and VSI shall provide to VitaminShoppe.com warehousing and fulfillment services.

The key difference between these two common types of contracts (consignment contract and wholesale-price contract) is the ownership of the goods kept in the shelves or warehouse of the retailer. More specifically, under consignment contract, the supplier keeps the ownership of the inventory and gains no payment until the product is sold by the retailer. This contract is also widely used in artist-gallery partnerships [2], the healthcare industry [3], [4], e-businesses [5], as well as traditional retail stores [6]. While under wholesale-price contract, the supplier produces the products ordered by the retailer while the retailer retains full ownership of the inventory and bears the risk associated with demand uncertainty.

Although there is rich literature on consignment contracting, most of them consider consider one supply chain. Different from previous research, we consider two competing supply chains, each consisting of one supplier and one exclusive retailer. In each supply chain, the supplier offers the retailer either a consignment contract or a wholesale price contract. Then, the retailer decides the retail price and the order quantity before demand is realized. The market demand is uncertain and price-sensitive, and it is decreasing in its own retail price and increasing in the competitor’s retail price.

Under such consideration, our research question are:

1. What are the equilibrium contracting strategies of competing supply chains, given two common
types of contacts (consignment contract and wholesale-price contract)?

2. How do the degrees of price sensitivities and retailer’s cost share rate (i.e., the portion of channel cost incurred at the retail stage) affect the decisions and performances?

To analyze the equilibrium behaviors of the suppliers and retailers, we examine the following three scenarios: (1) consignment contract scenario, where both suppliers offer consignment contracts; (2) wholesale-price contract scenario, where both suppliers offer wholesale-price contracts; and (3) hybrid contract scenario, where one supplier offers consignment contract and the other offers wholesale-price contract.

When the retailer (supplier) of each supply chain bears the same portion of the channel cost, we conclude that the equilibrium contract strategy depends on different price sensitivity and the retailer’s cost-share rate:

1. When consumers are very sensitive to the competitor’s retail price, the supplier will choose a different contract under different retailer’s cost-share rate: (i) when the supplier bears most of the channel cost, the equilibrium contract is wholesale-price contract; (ii) when the retailer bears most of the channel cost, the equilibrium contract is a consignment contract.

2. When consumers are slightly sensitive to the competitor’s retail price and the supplier bears most of the channel cost, the equilibrium strategy changes according to differing degrees of price sensitivity to the own product: (i) when the degree of price sensitivity is relatively large, the equilibrium contract is wholesale-price contract; (ii) when the degree of price sensitivity is relatively small, the equilibrium contract is consignment contract. When consumers are slightly sensitive to the competitor’s retail price and the retailer bears most of the channel cost, the equilibrium contract is still consignment contract.

The rest of this paper is organized as follows: Section II presents the analysis and results of the chain-to-chain competition model; Section III discusses the properties of the equilibrium solutions and provides some further numerical studies; and finally, Section IV concludes the paper.

II. The Model

We consider a market with two competing supply chains selling substitutable products, where each supply chain consists of a retailer and an exclusive supplier, as illustrated in Fig. 1.

The two retailers, suppliers and products are indexed by $i$ and $j$ where $i, j \in \{1, 2\}$, $i \neq j$. All players are risk neutral.

Demand for Product $i$, denoted by $D_i$, is price-sensitive and uncertain during a single selling season. Let $p_i$ represent the retail price of Product $i$. We adopt a widely used multiplicative demand model to capture price sensitivity and uncertainty of the demand [5], [7]:

$$D_i = y_i(p_i, p_j) \cdot \varepsilon,$$

where $y_i(p_i, p_j)$ is a deterministic demand function, decreasing in $p_i$ and increasing in $p_j$, and $\varepsilon$ is a random scaling factor with cdf $F(\cdot)$ and pdf $f(\cdot)$. Suppose that the probability density function has positive support on $[A, B] \subset \mathbb{R}^+$ with $B > A \geq 0$. Define the failure rate $h(x) \equiv \frac{f(x)}{F(x)}$, and assume that the failure rate of $\varepsilon$ is IFR (Increasing Failure Rate), i.e., $h'(x) > 0$. This is a relatively weak condition satisfied by many distributions such as normal, uniform, gamma and exponential, etc.

Furthermore, we let $y_i(p_i, p_j)$ take the following form:

$$y_i(p_i, p_j) = ae^{-\beta p_i + \gamma p_j}, \quad \beta > \gamma > 0,$$

where $\beta$ and $\gamma$ are each retailer’s own price sensitivity and the cross-price sensitivity, respectively. This model indicates that the expected demand of Retailer $i$ is increasing in the competitor’s retail price $p_j$ and decreasing in the corresponding retailer’s retail price $p_i$. This log-linear demand setting has been used in many related studies, e.g., [8], [9].

For Supplier $i$, producing Product $i$ costs $c_{Si}$ per unit. For Retailer $i$, there is a cost of $c_{Ri}$ per unit incurred for inventory handling, shelf-space usage, etc. Let $c_i$ denote the total cost of Chain $i$ which equals to $c_{Ri} + c_{Si}$, and let $\alpha_i$ represent the cost-share rate of Retailer $i$, $c_{Ri}/c_i$. For simplicity, we assume that there is no salvage value for any unsold product and no penalty cost for the unsatisfied demand.

We model the decision making of the supplier and the retailer as a Stackelberg game in each supply chain: Supplier $i$ ($i = 1, 2$), acting as the leader, decides the
contract strategy and offers his retailer a wholesale price \( w_i \) per unit ordered. Retailer \( i \), acting as a follower, chooses the order quantity \( q_i \) (stocking factor \( z_i \)) and the retail price \( p_i \). We investigate the game in the following three scenarios with different contract strategies:

- **Consignment Contract Scenario**: both supply chains use consignment contract where the retailer manages inventory but the supplier retains full ownership of the inventory. Since no payment to the suppliers is made until the product is sold, the suppliers bear all the risk associated with demand uncertainty.

- **Wholesale-price Contract Scenario**: both supply chains use wholesale-price contract where the retailers retain full ownership of the inventory that is placed on their shelves or in warehouses and bears all the risk associated with demand uncertainty.

- **Hybrid contract scenario**: one supply chain uses consignment contract and the other supply chain uses wholesale-price contract.

### A. Consignment Contract Scenario

Under each contract scenario, decisions are made in two sequential steps. At the first step, the suppliers decide the wholesale prices. At the second step, the retailers select the order quantities (stocking factors) and decide the wholesale prices. We use backward induction to obtain the equilibrium solutions.

In consignment contract scenario, for any given wholesale price, \( w_i \), the problem of Retailer \( i \) is to choose the stocking factor and the retail price to maximize her own expected profit which is expressed as

\[
\pi_{R_i}^{dc} = E[p_i - w_i - D_i(q_i)]
\]

\[
= y_i(z_i - \Lambda(z_i) - \alpha(c_i z_i)),
\]

where the superscript \( dc \) represents decentralized supply chain in consignment contract scenario.

Anticipating the retailer’s decisions, Supplier \( i \) sets the wholesale price \( w_i^{dc} \) to maximize his own expected profit which can be written as

\[
\pi_{S_i}^{dc} = E[w_i \min(D_i, q_i) - c_{S_i} q_i]
\]

\[
= y_i[w_i(z_i - \Lambda(z_i)) - (1 - \alpha_i) c_i z_i],
\]

where \( z_i \) is the optimal solution, denoted by \((z_i^{dc}, p_i^{dc}, w_i^{dc})\), can be obtained from the following proposition:

**Proposition 1**: Under consignment contract, the unique equilibrium stocking factor satisfies

\[
\frac{1}{\alpha_i c_i} = \frac{1}{1 - F(z_i^{dc})} - \frac{z_i^{dc}}{z_i^{dc} - \Lambda(z_i^{dc})},
\]

the unique equilibrium retail price satisfies

\[
p_i^{dc} = \frac{2}{\beta} + \frac{c_i z_i^{dc}}{z_i^{dc} - \Lambda(z_i^{dc})},
\]

and the unique equilibrium wholesale price satisfies

\[
w_i^{dc} = \frac{1}{\beta} + \frac{(1 - \alpha_i) c_i z_i^{dc}}{z_i^{dc} - \Lambda(z_i^{dc})}.
\]

Since we consider two competing supply chains, the unique equilibrium wholesale price and retail price are different from Adida and Ratisontorn’s paper [9] which discuss the model of one supplier selling products through two competing retailers. Proposition 1 imply that the equilibrium decisions \( z_i^{dc}, w_i^{dc} \) and \( p_i^{dc} \) are not affected by the competitor’s decisions. The price strategy that is independent of the competitor’s price decision is a well known property of a class of constant price elasticity demand model [10] and [11]. Because the multiplicative demand function \( q_i = \alpha_i p_i^{\beta}, i,j = 1, 2; i \neq j \) is a classic example of constant price elasticity demand model, and our demand model \( y_i = a e^{-\beta p_i + \gamma p_j} \) is related to an iso-price-elastic demand model after a transfer that \( \bar{p}_i = \log(p_i) \) as shown by [9]. The result that the optimal retail price \( p_i^{dc} \) is independent of \( p_j^{dc} \) is consistent with the previous findings of constant price elasticity demand model. With the similar reason, the optimal decision variables \( z_i^{dc}, w_i^{dc} \) also have the independent characteristic.

By substituting both (6) and (7) into (3) and (4), we obtain the optimal expected profits of Retailer \( i \) and Supplier \( i \) as follows

\[
\pi_{R_i}^{dc} = \frac{z_i^{dc} - \Lambda(z_i^{dc})}{\beta} y_i^{dc},
\]

\[
\pi_{S_i}^{dc} = \frac{z_i^{dc} - \Lambda(z_i^{dc})}{\beta} y_i^{dc},
\]

where \( y_i^{dc} = a e^{-\beta p_i^{dc} + \gamma p_j^{dc}} \).

Although [12] (Theorem 3) have shown related results of the optimal decision variables, the equilibrium performance of each firm is different from our model since they only consider a single supply chain. Furthermore, we obtain the following properties of decision variables:

**Proposition 2**: In consignment contract scenario,

1. the equilibrium stocking factor \( z_i^{dc} \) is decreasing in \( \beta, \alpha_i \) and \( c_i \);
2. the equilibrium wholesale price \( w_i^{dc} \) is decreasing in \( \beta \) and \( \alpha_i \);
3. the equilibrium retail price \( p_i^{dc} \) is decreasing in \( \beta \) and \( \alpha_i \).
Part (1) of Proposition 2 indicates the equilibrium stocking factor $z_i^{dc}$ decreases with the consumers’ price sensitivity, $\beta$, the cost-share rate of the retailer, $\alpha_i$, and the total cost of the supply chain, $c_i$. The higher the degree of price sensitivity, $\beta$, the lower the expected demand of Product $i$. Therefore, Retailer $i$ reduces the inventory to lower the cost of excess inventory. At the same time, the retailer orders less quantity to cut down the total cost if the unit cost $\alpha_i c_i$ increases. As shown in Part (2) and (3) of this proposition, the equilibrium wholesale price $w_i^{dc}$ and retail price $p_i^{dc}$ are both decreasing in price sensitivity, $\beta$, and retailer’s cost-share rate $\alpha_i$. Under consignment contract, the supplier bears all risk of demand uncertainty. When price sensitivity increases, the supplier charges a lower wholesale price so that the retailer can lower the retail price to attract more consumers. On the other hand, the lower cost-share rate of the retailer indicates a greater cost incurs at the supplier’s stage. Therefore, the supplier will charge a higher wholesale price to the retailer, which leads to an increase in retail price. The results of Proposition 2 that equilibrium decision variables decreases in $\beta$ confirm the related results in [9] (Proposition 3.10). Furthermore, our results extend to the case where there are two exclusive suppliers in the supply chains.

### B. Wholesale-price Contract Scenario

Under a basic wholesale-price contract, the retailers keep the ownership of the inventories and pay suppliers immediately when they receive the products. At the second stage, for any fixed wholesale price $w_i$, Retailer $i$ tries to maximize her expected profit function $\pi_{Ri}^{dW}$ which is given by

$$\pi_{Ri}^{dW} = E[p_i \min(D_i, q_i) - (w_i + c_{Ri})q_i] = y_i\{p_i[z_i - \Lambda(z_i)] - (w_i + \alpha_i c_i)z_i\}.$$  \hspace{1cm} (10)

We denote the optimal solution for Retailer $i$ as $(z_i^{dW}, p_i^{dW})$ which maximizes the profit function of (10). The superscript $dW$ represents the decentralized supply chain in the wholesale-price contract scenario.

Taking the retailers’ reaction functions into account, Supplier $i$ seeks optimal wholesale price $w_i^{dW}$ to maximize his own expected profit, $\pi_{Si}^{dW}$, which is written as

$$\pi_{Si}^{dW} = E[(w_i - c_S)q_i] = z_i y_i \{w_i - (1 - \alpha_i) c_i\}. \hspace{1cm} (11)$$

**Proposition 3:** For any given wholesale price $w_i$, the unique equilibrium $(z_i^{dW}, p_i^{dW})$ for the wholesale-price contract scenario satisfies:

$$\frac{1}{(w_i + \alpha_i c_i)\beta} = \frac{1}{1 - F(z_i^{dW})} - \frac{z_i^{dW}}{z_i^{dW} - \Lambda(z_i^{dW})} \hspace{1cm} (12)$$

and

$$p_i^{dW} = \frac{1}{\beta} + \frac{(w_i + \alpha_i c_i)z_i^{dW}}{z_i^{dW} - \Lambda(z_i^{dW})}. \hspace{1cm} (13)$$

Comparing the stocking levels of different scenarios, we have the following proposition:

**Proposition 4:** $z_i^{dW} < z_i^{dc}$.

The intuition for Proposition 4 is that since the retailer manages the inventory and bears all the risks related to demand uncertainty in the wholesale-price contract scenario, she orders less inventory compared to the scenario with consignment contract where she bears no risk of inventory.

Plugging (13) into (10) yields,

$$\pi_{Ri}^{dW} = \frac{[z_i^{dW} - \Lambda(z_i^{dW})]y_i^{dW}}{\beta}, \hspace{1cm} (14)$$

where $y_i^{dW} = ae^{-\beta p_i^{dW} + \gamma p_i^{dW}}$.

Since $z_i^{dW}$ and $p_i^{dW}$ are only known as implicit functions of $w_i$ according to (12) and (13), this problem has no analytical solution. According to (12), we find a one-to-one correspondence between the wholesale price and the stocking factor, and (12) can be rearranged as

$$w_i = \frac{1}{\beta} - \frac{1}{1 - F(z_i^{dW})} - \frac{z_i^{dW} - \Lambda(z_i^{dW})}{\alpha_i c_i}. \hspace{1cm} (15)$$

Substituting (15) into (13) and (11), we have

$$p_i^{dW} = \frac{z_i^{dW} - \Lambda(z_i^{dW})}{\beta [z_i^{dW} - \Lambda(z_i^{dW})]} F(z_i^{dW}) - \Lambda(z_i^{dW})]. \hspace{1cm} (16)$$

and

$$\pi_{Si}^{dW} = \left[\frac{1}{\beta} - \frac{1}{1 - F(z_i^{dW})} - c_i\right]z_i^{dW} y_i^{dW} \hspace{1cm} (17)$$

where $y_i^{dW} = ae^{-\beta p_i^{dW} + \gamma p_i^{dW}}$. 

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**TABLE I. PAYOFF TABLE FOR STRATEGIC CHOICE OF CONTRACTS**

<table>
<thead>
<tr>
<th>Chain 1</th>
<th>Chain 2</th>
<th>Consignment Contract</th>
<th>Wholesale-price Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consignment Contract</td>
<td>$(\pi_{R1}^{dc}, \pi_{S1}^{dc})$</td>
<td>$(\pi_{R2}^{dc}, \pi_{S2}^{dc})$</td>
<td></td>
</tr>
<tr>
<td>Wholesale-price Contract</td>
<td>$(\pi_{R1}^{dW}, \pi_{S1}^{dW})$</td>
<td>$(\pi_{R2}^{dW}, \pi_{S2}^{dW})$</td>
<td></td>
</tr>
</tbody>
</table>
### C. Hybrid Contract Scenario

In hybrid contract scenario, one supply chain uses consignment contract and the other uses wholesale-price contract. Without loss of generality, we suppose that Supplier $i$ offers consignment contract and Supplier $j$ offers wholesale-price contract, where $i, j = 1, 2, i \neq j$. The superscripts $hc$ and $hw$ represent respectively the supply chain under consignment contract and the supply chain under wholesale-price contract in hybrid contract scenario.

Based on the analysis of consignment contracts scenario and wholesale-price contracts scenario, we find the decisions $(z_i, p_i$ and $w_i)$ are not affected by the competitor’s decisions due to our demand assumption. Hence, we have the following relationship: the stocking factors satisfy

$$z_i^{hc} = z_i^{dc}, z_j^{hw} = z_j^{dw};$$

(18)

the optimal retail prices satisfy

$$p_i^{hc} = p_i^{dc}, p_j^{hw} = p_j^{dw};$$

(19)

and the optimal wholesale prices satisfy

$$w_i^{hc} = w_i^{dc}, w_j^{hw} = w_j^{dw}.$$

(20)

According to these relationships, we obtain the optimal expected profits of Retailer $i$ and Supplier $j$ as follows:

$$\pi_i^{hc} = \pi_i^{hc} = ae^{-\beta p_i^{hc} + \gamma p_j^{hw}} \frac{z_i^{hc} - \Lambda(z_i^{hc})}{\beta};$$

(21)

and the optimal expected profits of Retailer $j$ and Supplier $j$ as follows:

$$\pi_j^{hw} = ae^{-\beta p_i^{hc} + \gamma p_j^{hw}} \frac{z_j^{hw} - \Lambda(z_j^{hw})}{\beta},$$

(22)

and

$$\pi_j^{hw} = ae^{-\beta p_i^{hc} + \gamma p_j^{hw}} \left[ \frac{1}{\beta} \frac{z_j^{hw}}{z_j^{hw} - \Lambda(z_j^{hw})} - c_j \right].$$

(23)

### III. Equilibrium Contracting Strategy

We consider the model of two competing supply chains to investigate the equilibrium contracting strategies for supply chain leaders based on Table I. Since suppliers are the game leaders in our model, the optimal contracting strategies of supply chains are determined by the suppliers. Furthermore, $\pi_i^{dc} - \pi_i^{hc}$ and $\pi_i^{hc} - \pi_i^{hw}$ leads to that $\pi_i^{dc} - \pi_i^{hw}$ and $\pi_i^{hc} - \pi_i^{hw}$ have the same sign.

The discussions in the previous section indicate that equilibrium contracting issue can not be solved analytically. Thus, we investigate numerical study to examine the impact of retailer’s cost ratio and price sensitivity parameters on the individual decisions and performances under different contract. We normalize the cost parameters $c_i = c_j = 1$, and consider $\alpha_1 = \alpha_2 = \alpha$ where $\alpha = 0, 0.1, ..., 1$, and $a = 1, 10, 100$. Then, we test the uniform distributions on $[0, B]$ for $B = 1, 2, 5, 10...100$. We find that the observations are very similar. Therefore, we suppose that $a = 10$ and use an uniformly distributed example where $B = 2.5$ to illustrate the equilibrium decision variables in different scenarios.

Fig. 2. Changes in Decision Variables under Different $\beta$

According Fig. 2, we find the following observation,

**Observation 1:** $w_i^{dw}(w_i^{hc}), p_i^{dw}(p_i^{hc}), z_i^{dw}(z_i^{hc})$ are decreasing in $\beta$.

Observation 1 confirms the finding in [9] that $w_i^{dw}(w_i^{hc}), p_i^{dw}(p_i^{hc})$ are decreasing in $\beta$. However, the observation that $z_i^{dw}(z_i^{hc})$ decreases in $\beta$ is different from [9] that find the stocking level is not monotonic in $\beta$. By Observation 2 and Proposition 2, we find that the equilibrium wholesale prices, stocking factors and retail prices are all decreasing in price sensitivity, $\beta$, under different contract. Since the expected demand of Product $i$ decreases when the consumers are more sensitive to the product’s retail price, Retailer $i$ prefers to set a lower order quantity to reduce the risk of overstocking as $\beta$ increases. At the same time, the supplier prefers to charge a lower wholesale price to make the retailer set a lower retail price to attract more consumers.

Further based on Fig. 2, we have the following observation:

**Observation 2:**
1. $w_i^{wc}(w_i^{hc}) > w_i^{dw}(w_i^{hc})$;
2. $p_i^{dc}(p_i^{hc}) > p_i^{hw}(p_i^{hc})$, $i = 1, 2$.

Observation 2 extends the observation in [9] to chain-to-chain competition.

We summarize the comparison of suppliers’ profits under different $\alpha$, $\beta$ and $\gamma$ in Table II. According to Table I and II, we obtain the equilibrium strategies of the two supply chains in different conditions as shown...
in Fig. 3. The left figure of Fig. 3 depicts the Nash Equilibrium in the case that $\gamma$ is small, while the right figure of Fig. 3 shows the Nash Equilibrium in the case that $\gamma$ is large.

When $\gamma$ is small, the equilibrium strategies change when $\alpha$ is small as shown in the left figure of Fig. 3. The contracting strategy is different according to different $\beta$. When $\gamma$ is small, the substitution effect of the competitor is very small. Furthermore, if $\beta$ is also relatively small and approaches to $\gamma$, the retail prices have little effect on the demand. In this case, the suppliers would like to choose consignment contract. The retail prices and wholesale prices under consignment contract are higher than those under wholesale-price contract, but the demand is hardly influenced by the prices, which yields higher revenue to the suppliers under consignment contract. If $\beta$ is relatively large, a higher retail price leads to a lower demand. So the suppliers will likely choose wholesale-price contract to prevent lower demand and the risk of inventory. When $\gamma$ is small and $\alpha$ is large, suppliers choose the consignment contract. The reason is that suppliers bear less supply chain cost when $\alpha$ is large, and can obtain greater revenue by setting higher wholesale price under consignment contract.

![Fig. 3. Equilibrium contract strategy under different $\alpha$, $\beta$ and $\gamma$ in symmetric system](image)

In the right figure of Fig. 3 where $\gamma$ is large, the competition of two supply chains is more intense. In this case, the suppliers select different contracts with respect to the cost-share rate as follows: (1) When $\alpha$ is small, the suppliers bear most of the supply chain cost. Then, the suppliers select wholesale-price contract, where the retailers bear all of the inventory risk, to cut down the cost; (2) When $\alpha$ is large, the retailers bear most of the supply chain cost. In that case, the suppliers choose consignment contract, where the suppliers set a higher wholesale price, to obtain more revenue.

IV. CONCLUSIONS

In this paper, we investigated the equilibrium contracting strategies in two competing supply chains where the supplier acted as the leader and the retailer acted as the follower in each supply chain. We analyzed the performance of consignment contract and wholesale-price contract in three scenarios and derived the corresponding equilibrium strategies under different price-sensitivity and retailer’s cost-share rate.

In symmetric supply chain system, we observe that consignment contract is the equilibrium strategy of the two supply chains when either (1) the cost-share rate is large, or (2) the cost-share rate and price sensitivities are small; otherwise, wholesale-price contract is the equilibrium strategy of the two supply chains.

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