SUPPLY CHAIN COORDINATION UNDER DISRUPTIONS

LI, WANG, ZI WANG AND QINGLING ZHANG

Abstract. This paper studies the coordination problem under disruptions capturing by the change of market scale and price sensitive coefficient in a one-supplier-one-retailer supply chain system, gives the supply chain coordination scheme based on $AQD(w_1, w_2, Q)$ and $CLP(w, Q)$ policies. Our results show that supply chain can be full coordinated so that maximum potential profit is obtained for disruptions.

Key Words. supply chain coordination, disruption management, quantity discount, price sensitive coefficient, market scale.

1. Introduction

Recently the supply chain coordination has been a very active research area and has obtained a lot of research results [1, 2, 3, 4, 5, 6]. In the absence of any disruption, the member in the chain operate smoothly. However, unexpected even could cause a sever disruption to the system and lead to huge loss. Supply chain disruption management is relatively new, supply chain coordination under disruption was firstly present by Qi. Qi et al [7] studied coordination of a one-supplier-one-retailer supply chain with demand disruption and they introduced an all-unit wholesale quantity discount coordination mechanism. Yu [8] dealt with supply chain coordination under disruptions with buy back contract, the optimal strategy for supply chain to the disruptions was given and as optimal response for the supply chain to the disruptions, an adjusted buy back contract which has anti-disruption-ability was proposed and some managerial insights were provided. Xu [9] systemically analyzed the demand disruption problem with nonlinear demand function, showed how to effectively handle the demand uncertainty in a supply chain, both for the case of centralized-decision-making system and the case of decentralized-decision-making system with perfect coordination. Yu [11] studied the supply chain coordination under the change of price sensitive coefficient. Xiao [10] introduced a supply chain coordination model in which there were one manufacturer and two competing retailers.

In this paper, we extend the literature [7]’s result to disruption caused by two factor, i.e. market scale and price sensitive coefficient. We analyze the impact of disruption on a supply chain with one-supplier-one-retailer, give the supply chain coordination model.

The rest of the paper is organized as follows. Section 2 gives the problem description. Section 3 deals with centralized decision making after disruption. Section 4 studies the coordination of a supply chain. In section 5, some numerical examples will be given to illustrate the theory result and Section 6 is conclusion.
2. Problem model

We consider the supply chain system contains one-supplier-one-retailer, the product of interest has a short life cycle with a market demand, the supplier produces one type of product and sells the product to the retailer by wholesale price, the retailer then sells the product to an open market by retail price. Under the assumption that the supplier and the retailer can obtain information symmetrically, the supplier first makes production plan based on market forecast. When the actual demand is known, he declares a wholesale price for the retailer who then decides the quantity of product to order and retail price to set. Both of whom are independent decision-makers seeking for maximize their individual profit. Usually, the maximum total supply chain profit may not be achieved without coordination each other. The basic purpose of supply chain coordination is to devise a mechanism that will induce the retailer to order the right quantity of product and set the right retail price so that the total profit of the supply chain is maximized [7]. Let $c$ be the supplier’s unit production cost and $p$ be unit retail price respective. Suppose the the market demand is described by the relationship $d = D - kp$, where $D$ is the market scale (i.e., the maximum possible demand), $d$ is the real demand under retail price $p$, $k$ is a price-sensitive coefficient.

The supply chain profit is $f_{SC} = (D - kp)(p - c)$, here $p$ is decision variable.

It is easy to see that $f_{SC}$ is maximized at $\bar{p} = \left(\frac{D + kc}{2k}\right)$, $f_{SC}_{\text{max}} = \left(\frac{D - kc}{4k}\right)^2$. The optimal production quantity is $\bar{Q} = \left(\frac{D - kc}{2}\right)$.

Two quantity discount policies [7] are given as follows:

**Definition 2.1.** An all-unit wholesale quantity discount policy AQD($w_1, w_2, q_0$) with $w_1 > w_2$, work as follows. If the retailer orders $Q < q_0$, the unit wholesale price is $w_1$. If the retailer orders $Q \geq q_0$, the unit wholesale price becomes $w_2$.

**Definition 2.2.** A capacitated linear pricing policy CLP($w, Q$) with the following characteristics. The unit wholesale price is $w$, but the retailer is restricted to ordering no more than the quantity $Q$.

The follow lemma [7] indicates that the supplier can set an all-unit quantity discount to induce the retailer to set the “right” order and retail price so that the supplier’s goal of profit and the maximum supply chain profit can be obtained.

**Lemma 2.1.** For $f^S = \eta f_{SC}^{\text{max}}$, $0 < \eta < 1$, the supply chain can be coordinated under the quantity discount policy AQD($\bar{w}_1, \bar{w}_2, Q$) where $\bar{w}_1$ is large enough and $\bar{w}_2 = c + \eta\left(\frac{D + kc}{2k} - c\right)$

In this paper, the disruption model is considered contains two time periods. In first period, a production plan is built on the assumption that demand is given by $d = D - kp$. In second period, the realized demand is described as $Q = D + \Delta D + (k + \Delta k)p$, where the disruption is captured by the term $\Delta D$ and $\Delta k$. The problem is what coordination mechanisms are found to help the supply chain react to the disruption.

3. Centralized decision making after disruption

In this disruption model, let $\Delta Q$ be the production deviation, i.e. $\Delta Q = Q - \bar{Q}$. When $\Delta Q > 0$, production must be increased to satisfy the new demand. The unit production cost for the additional demand will be more than the unit production
cost $c$ for original demand due to the need to use more expensive resources. When $\Delta Q < 0$, there are following three possibly cost: i) Inventory cost, ii) The cost of scraping excess product, and iii) The cost causing by sold at a price much below $p$. this marginal extra unit cost is demote. Let $\lambda_1, \lambda_2 > 0$, be marginal extra unit cost of increased and decreased production from the original plan respective.

From the central decision-maker’s point of view, the supply chain profit under disruption can be written as

\[
F^{ac}(Q) = Q\left(\frac{D + \Delta D - \Delta k}{k + \Delta k} - c \right) - \lambda_1(Q - \bar{Q})^+ - \lambda_2(\bar{Q} - Q)^+
\]

where and $a^+ = \max[0, a]$

Lemma 3.1. Suppose $Q^*$ is an optimal solution so that maximizes $F^{ac}(Q)$ in (1). Then

1. $Q^* > \bar{Q}$, if $-k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}$.
2. $Q^* < \bar{Q}$, if $\Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}$, or $\Delta k > -k$ and $\Delta D \leq -Kc$.
3. $Q^* = \bar{Q}$, if $\frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2}$ and $\Delta D > -kc$.

Proof. (1) Assume $Q^* \leq \bar{Q}$, when $-k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}$.

Since $Q^*$ is an optimal solution, $F'(Q^*) = 0$  
$\Rightarrow Q^* = \frac{D - kc}{2} + \frac{\Delta D - c\Delta k + \lambda_2(k + \Delta k)}{2}$

Recall that $\bar{Q} = \frac{D - kc}{2}$

By $Q^* \geq \bar{Q}$, $\Rightarrow \Delta k \geq \frac{\Delta D - k\lambda_1}{c + \lambda_1}$

This is contradiction with $\Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}$. Therefore $Q^* > \bar{Q}$. Similarly, (2) and (3) can be proofed.

Theorem 3.1. Give a disruption is captured by the term $\Delta D$ and $\Delta k$, when the demand function is $d = D + \Delta D - (k + \Delta k)p$, the supply chain profit is maximized for the following values of the production order quantity $Q$ and the retail price $p$.

\[
Q^* = \begin{cases} 
\bar{Q} + \frac{\Delta D - k\lambda_1 - \Delta k(c + \lambda_1)}{2}, & \text{if } -k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}, \\
\bar{Q}, & \text{if } \frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2} \text{ and } \Delta D > -kc, \\
\bar{Q} + \frac{\Delta D + k\lambda_2 - \Delta k(c - \lambda_2)}{2}, & \text{if } \Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}, \\
\text{or } \Delta k > -k \text{ and } \Delta D \leq -Kc.
\end{cases}
\]
Recall that the supplier’s profit is given by

\[ p^* = \begin{cases} 
\frac{D + \Delta D + (k + \Delta k)(c + \lambda_1)}{2(k + \Delta k)}, & \text{if } -k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}, \\
\frac{D + 2\Delta D + kc}{2(k + \Delta k)}, & \text{if } \frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2} \text{ and } \Delta D > -kc, \\
\frac{D + \Delta D + (k + \Delta k)(c - \lambda_2)}{2(k + \Delta k)}, & \text{if } \Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}, \text{ or } \Delta k > -k \text{ and } \Delta D \leq -Kc.
\end{cases} \]

The maximum profit of the supply chain is

\[ F_{sc}^{\text{max}} = \begin{cases} 
\frac{[D + \Delta D - (k + \Delta k)(c + \lambda_1)]^2}{4(k + \Delta k)} + \lambda_1\bar{Q}, & \text{if } -k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}, \\
\frac{D - kc[D + 2\Delta D + kc - c]}{2(k + \Delta k)}, & \text{if } \frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2} \text{ and } \Delta D > -kc, \\
\frac{[D + \Delta D - (k + \Delta k)(c - \lambda_2)]^2}{4(k + \Delta k)} - \lambda_2\bar{Q}, & \text{if } \Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}, \text{ or } \Delta k > -k \text{ and } \Delta D \leq -Kc.
\end{cases} \]

4. The supply chain coordination policy under disruption

When market scale and price-sensitive coefficient change from \( D, k \) to \( D + \Delta D \) and \( k + \Delta k \), the original coordination policy will be infeasible. Therefore it is necessary to take a new policy to coordinate the supply chain. In this section, we discuss how the supplier should devise a new scheme to achieve the supply chain coordination for disruption.

4.1. When \(-k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1}\). Recall that \( F_{sc}^{\text{max}} \) can be written as

\[ F_{sc}^{\text{max}} = \frac{[D + \Delta D - (k + \Delta k)(c + \lambda_1)]^2}{4(k + \Delta k)} + \lambda_1\bar{Q} \tag{2} \]

Note that the first term on the right side is positive in (2), suppose the profit that would like to earn is \( F^* \), then we will have two cases: \( F^* \geq \lambda_1\bar{Q} \) and \( F^* < \lambda_1\bar{Q} \).

4.1.1. Case \( F^* \geq \lambda_1\bar{Q} \).

**Theorem 4.1.** When \(-k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1} \) and \( F^* \geq \lambda_1\bar{Q} \) with \( 0 \leq \eta < 1 \), the supply chain can be coordinated by \( AQD(w_1, w_2, Q^*) \), where

\[ w_2 = c + \lambda_1 + \eta \frac{D + \Delta D - (c + \lambda_1)(k + \Delta k)}{2(k + \Delta k)} \]

**Proof.** The supplier’s profit is

\[ F^* = \eta \frac{[D + \Delta D - (k + \Delta k)(c + \lambda_1)]^2}{4(k + \Delta k)} + \lambda_1\bar{Q} \]

where \( 0 \leq \eta < 1 \) is a parameter specified by the supplier.
The retailer’s profit can be written as

\[ F^r = F_{\text{max}}^{sc} - F^s = (1 - \eta) \frac{[D + \Delta D - (k + \Delta k)(c + \lambda_1)]^2}{4(k + \Delta k)} \]

We can imply

\[ w_2 = c + \lambda_1 + \eta \frac{D + \Delta D - (c + \lambda_1)(k + \Delta k)}{2(k + \Delta k)} \]

by \( F^r = Q^*(p^* - w_2) \).

If the retailer orders more than \( Q^* \) and takes the wholesale price \( w_2 \), then his profit function is

\[ F^r(Q) = Q \left( \frac{D + \Delta D - Q}{k + \Delta k} - w_2 \right) \]

which is maximize at

\[ Q_r = \frac{D + \Delta D - (k + \Delta k)w_2}{(k + \Delta k)} \]

It can be shown that \( Q_r \leq Q^* \). If \( Q_r < Q^* \) (i.e. the retailer orders less than \( Q^* \)), he has to take the wholesale price \( w_1 \). In this case, when \( w_1 \) is enough,

\[ F^r(Q_r) < F^r(Q^*) \]

Thus the retailer would like to order \( Q^* \) with the wholesale price \( w_2 \) to maximize his own profit. As a result the supplier’s desired profit and the maximum supply chain profit are achieved. The supply chain can be coordinated by \( AQD(w_1, w_2, Q^*) \).

4.1.2. Case \( F^s < \lambda_1 \bar{Q} \).

**Theorem 4.2.** When \( -k < \Delta k < \frac{\Delta D - k\lambda_1}{c + \lambda_1} \) and \( F^s = \eta\lambda_1 \bar{Q} \) with \( 0 < \eta < 1 \), the supply chain can be coordinated by \( CLP(w_2, Q^*) \), where

\[ w_2 = c + \lambda_1 + (\eta - 1) \frac{\lambda_1(D - kc)}{D + \Delta D - (k + \Delta k)(c + \lambda_1)} \]

**Proof.** The supplier’s profit is \( F^s = \eta\lambda_1 \bar{Q} \), where \( 0 < \eta < 1 \).

The retailer’s profit can be written as

\[ F^r = F_{\text{max}}^{sc} - F^s = \frac{[D + \Delta D - (k + \Delta k)(c + \lambda_1)]^2}{4(k + \Delta k)} + (1 - \eta)\lambda_1 \bar{Q} \]

We can imply

\[ w_2 = c + \lambda_1 + (\eta - 1) \frac{\lambda_1(D - kc)}{D + \Delta D - (k + \Delta k)(c + \lambda_1)} \]

by \( F^r = Q^*(p^* - w_2) \).

If the retailer orders more than \( Q^* \) and takes the wholesale price \( w_2 \), then his profit function is

\[ F^r(Q) = Q \left( \frac{D + \Delta D - Q}{k + \Delta k} - w_2 \right) \]

which is maximize at

\[ Q_r = \frac{D + \Delta D - (k + \Delta k)w_2}{(k + \Delta k)} \]

It can be shown that \( Q_r > Q^* \) which implies that the retailer will order \( Q_r \) rather than \( Q^* \). In this case, the supply chain can’t be coordinated by \( AQD(w_1, w_2, Q^*) \) and can be coordinated by \( CLP(w_2, Q^*) \).
4.2. When $\frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2}$ and $\Delta D > -kc$.

**Theorem 4.3.** When $\frac{\Delta D - k\lambda_1}{c + \lambda_1} \leq \Delta k < \frac{D + 2\Delta D - kc}{2c}$ and $\Delta D > -kc$, for $F^* = \eta F^*$, then

(i) the supply chain can be coordinated by $AQD(w_1, w_2, Q^*)$, if

$$\eta > \frac{2(\Delta D - c\Delta k)}{D + 2\Delta D - kc - 2c\Delta k}$$

(ii) the supply chain can be coordinated by $CLP(w_2, Q^*)$, if

$$\eta \leq \frac{2(\Delta D - c\Delta k)}{D + 2\Delta D - kc - 2c\Delta k}$$

where

$$w_2 = c + \eta\left(\frac{D + 2\Delta D + ck}{2(k + \Delta k)} - c\right)$$

The proof is similar to that of Theorem 4.1 and Theorem 4.2 and is omitted.

Unfortunately, the policies enumerated in Theorem 4.3 can’t be applied when $\Delta k \geq \frac{D + 2\Delta D - kc}{2c}$. In this case, because

$$p^* - w_2 = (1 - \eta)(\frac{D + 2\Delta D + kc}{2(k + \Delta k)} - c) \leq 0$$

which means that the retailer’s profit isn’t positive. In fact, the retailer has the option of not ordering any product if he can’t make any profit. If no order is placed, the supplier will be forced to dispose of his entire $\bar{Q}$ products at a loss of $-\lambda_2\bar{Q}$. To reduce this loss, the supplier need to set a new wholesale price policy that induces the retailer to order at least some amount of product. We devise an optimal wholesale price from the retailer’s point of view.

Support that the retailer must earn a profit of

$$F^r = -\mu F^r_{max} = -\mu \left[\frac{D - kc}{2}\left(\frac{D + 2\Delta D + kc}{2(k + \Delta k)} - c\right)\right]$$

where $\mu > 0$, $F^r_{max} < 0$.

Then the supplier’s profit becomes

$$F^s = F^r_{max} - F^r = (1 + \mu)\frac{D - kc}{2}\left(\frac{D + 2\Delta D + kc}{2(k + \Delta k)} - c\right)$$

However, when the retailer gets too greedy, as indicated by a large value of $\mu$, the supplier will minimize his losses by simply disposing of his entire lots $\bar{Q}$. Thus $F^s > -\lambda_2\bar{Q}$ should be satisfied, i.e.

$$\mu < -\frac{2\lambda_2(k + \Delta k)}{D + 2\Delta D - kc - 2c\Delta k} + 1$$

We can imply

$$w_2 = \frac{D + 2\Delta D + ck}{2(k + \Delta k)} + \mu\left(\frac{D + 2\Delta D + ck}{2(k + \Delta k)} - c\right)$$

by $F^r(Q) = Q(\frac{D + \Delta D - Q}{k + \Delta k} - w_2)$

**Theorem 4.4.** When $\frac{D + 2\Delta D - kc}{2c} \leq \Delta k \leq \frac{\Delta D + k\lambda_2}{c - \lambda_2}$ and $F^r = -\mu F^*$, then

(i) the supply chain can be coordinated by $AQD(w_1, w_2, Q^*)$, if

$$0 < \mu \leq -\frac{D - kc}{D + 2\Delta D - kc + 2c\Delta k}$$
(ii) the supply chain can be coordinated by CLP$(w_2, Q^*)$, if

$$-\frac{D - kc}{D + 2\Delta D - kc + 2c\Delta k} < \mu < -\frac{2\lambda_2(k + \Delta k)}{D + 2\Delta D - kc - 2c\Delta k} + 1$$

(iii) the supplier would like to dispose of all $\bar{Q}$ products at the secondary market, if

$$\mu \geq -\frac{2\lambda_2(k + \Delta k)}{D + 2\Delta D - kc - 2c\Delta k} + 1$$

where

$$w_2 = \frac{D + 2\Delta D + ck}{2(k + \Delta k)} + \mu\left(\frac{D + 2\Delta D + ck}{2(k + \Delta k)} - c\right)$$

Proof. If the retailer accepts the wholesale price $w_2$, his profit can be written as

$$F_r(Q) = Q\left(\frac{D + \Delta D - Q}{k + \Delta k}\right)$$

which is maximized at

$$Q_r = \frac{D + \Delta D - (k + \Delta k)w_2}{(k + \Delta k)}$$

When

$$\mu \leq -\frac{D - kc}{D + 2\Delta D - kc + 2c\Delta k}, \quad Q_r \leq \bar{Q}$$

When

$$\mu > -\frac{D - kc}{D + 2\Delta D - kc - 2c\Delta k}, \quad Q_r > \bar{Q}$$

The surplus proof is similar to that of 4.1 and 4.2.

4.3. When $\Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}$, or $\Delta k > -k$ and $\Delta D \leq -kc$.

Theorem 4.5. When $\Delta k > \max\{\frac{\Delta D + k\lambda_2}{c - \lambda_2}, -k\}$, or $\Delta k > -k$ and $\Delta D \leq -kc$ then

(i) the supply chain can be coordinated by AQD$(w_1, w_2, Q^*)$, if

$$0 < \mu < \frac{\left[D + \Delta D - (k + \Delta k)(c - \lambda_2)\right]^2}{2\lambda_2(k + \Delta k)(D - kc)}$$

(ii) the supplier would like to sell all of $\bar{Q}$ products at the secondary market, if

$$\mu < 0 \quad \text{or} \quad \mu \geq \frac{\left[D + \Delta D - (k + \Delta k)(c - \lambda_2)\right]^2}{2\lambda_2(k + \Delta k)(D - kc)}$$

where

$$w_2 = c - \lambda_2 + \frac{\mu\lambda_2(D - kc)}{D + \Delta D - (k + \Delta k)(c - \lambda_2)}$$

5. Numerical examples

In this section several numerical examples will be given to illustrate the way of coordinating supply chain with disruption in this paper.

Let the originally estimated market scale $D = 14$, the price sensitive coefficient $k = 2$, the unit production cost $c = 1$, then $d = 14 - 2p$. The optimal order quantity and optimal retail price are respective $\bar{Q} = 6$, $\bar{p} = 4$, the maximum profit of supply chain is $f_{\text{max}} = 18$. For the marginal cost of deviation from the production plan, we assume $\lambda_1 = \lambda_2 = 0.5$. In other words, producing one unit of the product more than the original plan costs the supplier 1.5, and handling one unit leftover inventory costs the supplier 0.5.
We have considered various magnitudes of possible disruptions of the market scale and price sensitive coefficient. For different $\Delta D$ and $\Delta k$, we calculate the profit differences of the supplier, the retailer and the supply chain between taking disruption management and keeping the original wholesale quantity discount policy. The results see Table 1 and Table 2.

### Table 1. The coordination scheme

<table>
<thead>
<tr>
<th>$\Delta D$</th>
<th>$\Delta k$</th>
<th>OC</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>$AQD(5,3,6.75)$</td>
<td>$F^s \geq \lambda_1 Q, AQD(4,3,6.75)$</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>$AQD(5,1.4,4.5)$</td>
<td>$F^s &lt; \lambda_1 Q, CLP(1.4,6.75)$</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>$AQD(5,3,0)$</td>
<td>$\mu &lt; 1, AQD(5,0.8,5.5)$</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>$AQD(5,3,1.5)$</td>
<td>$\eta &lt; 1/7, AQD(5,1.3,6)$</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>$AQD(5,3,1.5)$</td>
<td>$\eta \geq 1/7, CLP(1.1,6)$</td>
</tr>
</tbody>
</table>

### Table 2. The member’s profits in supply chain

<table>
<thead>
<tr>
<th>$\Delta D$</th>
<th>$\Delta k$</th>
<th>OC</th>
<th>NC</th>
<th>OC</th>
<th>NC</th>
<th>OC</th>
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<tr>
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<td>13.1</td>
<td>5.1</td>
<td>5.1</td>
<td>18.2</td>
<td>18.2</td>
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<td>1</td>
<td>8.3</td>
<td>2.3</td>
<td>3.6</td>
<td>15.6</td>
<td>11.9</td>
<td>18.2</td>
</tr>
<tr>
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<td>8</td>
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<td>-1.7</td>
<td>0</td>
<td>1.7</td>
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<td>0</td>
</tr>
<tr>
<td>4</td>
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<td>0.75</td>
<td>1.8</td>
<td>0.45</td>
<td>0.6</td>
<td>1.2</td>
<td>2.4</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>0.75</td>
<td>0.6</td>
<td>0.45</td>
<td>1.8</td>
<td>1.2</td>
<td>2.4</td>
</tr>
</tbody>
</table>

In Table 1 and Table 2, NC denotes the result of re-coordinating supply chain after the supplier known the disruption and OC denote the result of coordinating supply chain when the supplier is unaware of the disruption.

In Table 1 and Table 2, the rows of $\Delta D = 4$ and $\Delta k = 1$ belong to the case of Theorem 4.1 and Theorem 4.2, we can see that if the wholesale price equivalent under new coordination and original coordination, the profit of the supplier, retailer and the supply chain aren’t change. If the wholesale price is not equivalent, the maximum supply chain’s profit cannot achieved with original coordination. All the members in supply chain can achieve more profit with new coordination than original and supplier’s profit is maximum. The row of $\Delta D = 2$ and $\Delta k = 8$ belongs to the case of Theorem 4.5. In this case, the supplier’s profit is negative. The retailer would order nothing if uses original coordination and supplier’s profit is -3, In order to reduce his own loss, the supplier would like to take new discount policy so that retailer’s profit is 1.7 and the supplier can reduce his own loss too. The rows of $\Delta D = 4$ and $\Delta k = 3$ belong to Theorem 4.3. In this case, all the member’s profit are positive with new discount policy. If the supplier takes the original policy, the supplier’s profit is increase a few, but the retailer’s profit is decrease more and the maximum supply chain’s profit can not reach.

6. Conclusion

In this paper, we study how to coordinate supply chain with disruption. The change of market scale and price sensitive coefficient may cause market demand disruption and the production quantity differing from what has been planned. The
previous research considers only a factor’s change, i.e. market scale or price sensitive coefficient, this paper give the coordination scheme of supply chain which two factor’s change at the same time.

References


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