Collaborative Sale Contract in Publishing Supply Chain

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Abstract: In Japan, books and magazines have been distributed under the resale price maintenance and consignment sale systems. At present, the return rate of books and magazines has reached approximately 40 percent of the quantity of publications under the systems mentioned above. This is a severe problem from the viewpoints of both business and environment. For the purpose of solving this problem, a new sale system where wholesale price is reasonable while buyback price is inexpensive has been programmed and practiced. The wholesale and buyback prices are important contract parameters in the transaction program between publisher and bookstore. In this paper, the publishing supply chain consisting of a publisher and a bookstore is formulated as a mathematical model. Then, we have developed a new approach to solve the collaborative sale contract problem with wholesale and buyback prices as contract parameters.

Key Words: buyback contract, consignment sale system, coordination approach, incentive compatible condition, Nash bargaining solution, resale price maintenance system

1. Introduction

The industry of publication in Japan had been increasingly growing until 1996, but has been declining since 1996. The rate where the books and magazines have been returned from bookstore to publisher has been reaching approximately 40 percent over decade [1]. This phenomenon has been a severe problem.

The distribution of books, magazines, music compact discs and newspapers in Japan has been operated according to the following two sale systems: resale price maintenance and consignment sale systems. The retail price of publications is nationwide unique at any bookstores, because the bookstore cannot change it under the resale price maintenance system. Hence, the people can purchase the same book with an identical price regardless of the difference of costs including transportation. The resale price maintenance system plays an important role with respect to the diffusion of Japanese culture. On the other hand, unsold items of the general goods which are not treated under the resale price maintenance system can be discounted and sold. However, the retail price of publications is not accountable under the resale price maintenance system. Then, the distribution quantity of books and magazines may be inhibited because the bookstore wishes to avoid the risk of dead stock due to unchangeable retail price. Accordingly, publishers fear that the market of books and magazines might shrink. Therefore, for the purpose to prevent the problem about shrinking the markets, a consignment sale system where all dead stocks were bought back with the same price as wholesale price has been introduced.

However, the parallel operation of the resale price maintenance and consignment sale systems has induced the negligence of sale plan and sales effort in the bookstores. Then, unneeded orders have been a daily occurrence. As a result, the return rate of books and magazines has reached approximately 40 percent of the quantity of publications. This is a severe problem from the viewpoints of both business and environment. For details, see reference [2].

Recently, a new sale system of selling publications has been introduced to a part of books [3][4]. The sale system is called the responsible sale system, which is a provisional name. The wholesale price is a reasonable price in comparison to traditional one while the buyback price is inexpensive in comparison to traditional one under the new sale system. For detail, the wholesale price to bookstore is approximately 80% of retail price, and the buyback price is same as wholesale price under traditional consignment sale system. On the other hand, the wholesale price to bookstore is approximately 65% of retail price and the buyback price is approximately 35% of retail price under the new sale system. Although the responsible sale system imposes a part of risks of loss due to dead stocks on the bookstore, the bookstore has a chance to get further profit through a strategic plan for buying and selling publications.

In our study, the responsible sale system is considered the sale contract between publisher and bookstore. Then, we discuss a procedure for designing the contract between publisher and bookstore. On the other hand, the buyback contract is well known as one of supply chain contract techniques [5]. The coordination approach has been developed as the solution of supply chain contract technique. The responsible sale system is essentially same as the traditional buyback contract. From this, the traditional discussions may be useful for designing the sale contract between publisher and bookstore. Usually, the contract has to be justly beneficial to both of publisher and bookstore. Hence, several necessary conditions should be satisfied in order to keep both benefits of publisher and bookstore as same as the present status at least.
In this study, we propose a new successive approach to reach the conclusion of contract. In this process, the several necessary conditions in respective stages until the conclusion of contract are indicated. And then, the wholesale and buyback prices as contract parameters are collaboratively determined between publisher and bookstore. Naturally, the new approach proposed here includes the traditional coordination approach. The rest of this paper is as follows. In section 2, the trading model of publications between publisher and bookstore is formulated. Then, we show the combination of wholesale and buyback prices such that maintain the minimum profit of publisher and bookstore simultaneously in section 3. Section 4 proposes the collaborative coordination approach including the traditional coordination approach. In section 5, we propose a method of determining the unique combination of wholesale and buyback prices. Finally, we conclude this paper in section 6.

2. Model Setting

In this study, we consider a publishing supply chain which consists of a publisher and a bookstore and then deals with a single type of publications. A single type of publications is traded between a publisher and a bookstore at a wholesale price and is sold by the bookstore in the ordinary market during a specified sale period, for example, one week or month. The unsold publications (dead stocks) during the specified sale period are salvaged at a buyback price by the publisher, and then all of salvaged publications are disposed of.

The following notations for monetary description are defined in this paper, where the monetary descriptions are given as the ratio of retail price according to a custom of publishing industry:

\[ r : \text{retail price}, \]
\[ w \equiv k_w r : \text{wholesale price}, \]
\[ c \equiv k_c r : \text{original cost}, \]
\[ b \equiv k_b r : \text{buyback price}, \]
\[ a \equiv k_a r : \text{administration cost in bookstore}, \]
\[ v \equiv k_v r : \text{waste cost in publisher}. \]

The administration cost in the publisher is included in original cost. Then, as mentioned already, all of prices and expenses are given on the basis of retail price \( r \). Note that the opportunity loss for lost sales is not considered in this paper from avoiding complication and redundancy. It is easy to add the opportunity loss to the model. Also, the following relations are rationally satisfied: \( 0 < k_i < k_w < 1, k_b < k_w, 1 - k_w - k_a > 0, \) and \( k_w + k_a > k_b \). Then, the coefficients \( k_w \) and \( k_a \) are considered as the contract parameters and decision variables.

Further, we use the following notations for demand of publications during the specified sale period:

\[ x : \text{quantity of demand during specified sale period}, \]
\[ f(x) : \text{probability density function of } x, \]
\[ F(x) : \text{cumulative probability function of } x, \]
\[ \mu : \text{expectation of } x, \]
\[ \sigma^2 : \text{variance of } x, \]
\[ q : \text{trading quantity between publisher and bookstore}. \]

Next, we formulate the profit functions of publisher and bookstore using the notations mentioned above. The profit function of bookstore under the responsible sale system is given as follows:

\[
\pi^B = rS(q) - k_wrq - k_arq + k_brI(q)
\]
\[
= (1 - k_w - k_a)r q - (1 - k_b)r \int_0^q F(x)dx,
\]
where \( S(q) \) means an expected sale quantity and \( S(q) \) is given as follows:

\[
S(q) = q[1 - F(q)] + \int_0^q xf(x)dx
\]
\[
= q - \int_0^q F(x)dx. \tag{2}
\]

Also, \( I(q) \) means an expected unsold quantity, i.e., the expectation of the dead stock, and \( I(q) \) is given as follows:

\[
I(q) = q - S(q) = \int_0^q F(x)dx. \tag{3}
\]

Under the responsible sale system, the trading quantity is determined by a buyer, i.e., the bookstore in this study. Therefore, the following optimal trading quantity is obtained when the bookstore decides the trading quantity to maximize the profit function \( \pi^B \):

\[
F(q^B) = \frac{1 - k_w - k_a}{1 - k_b}. \tag{4}
\]

Similarly, we formulate the profit functions of publisher. The profit function of publisher under the responsible sale system is given as follows:

\[
\pi^P = k_wrq - k_arI(q) - k_arI(q) - k_arq
\]
\[
= (k_w - k_a)r q - (k_b + k_c)r \int_0^q F(x)dx. \tag{5}
\]

3. Incentive Compatible Condition

The respective profit functions of publisher and bookstore under the responsible sale system has been given by Eqs.(1) and (5). The bookstore is a decision-maker of trading quantity under the responsible sale system. Hence, the trading quantity is given as \( q^B \) in Eq.(4). In this case, the respective profit functions are considered as the function of the contract parameters \( k_a \) and \( k_b \), in other words,

\[
\pi^B \equiv \pi^B(k_a, k_b), \tag{6}
\]
\[
\pi^P \equiv \pi^P(k_a, k_b). \tag{7}
\]

On shifting from the consignment sale system to the responsible sale system, the publisher and bookstore must have an incentive to the shift of sale systems, individually. In other words, the compatible condition of individual rationality has to be considered. The respective profits of publisher and bookstore under the consignment sale systems are denoted as follows:
\( \pi_0^w \) : bookstore’s profit under the present consignment sale system,

\( \pi_0^p \) : publisher’s profit under the present consignment sale system.

Therefore, the incentives of publisher and bookstore to the shift of sale systems have to satisfy the following relations:

\[
\begin{align*}
\pi^B (k_w, k_b) &\geq \pi_0^B, \\
\pi^P (k_w, k_b) &\geq \pi_0^P.
\end{align*}
\]  

(8)

In this study, this is called an incentive compatible condition.

These profits, \( \pi_0^B \) and \( \pi_0^P \), may be evaluated using actual results at present situation. In this paper, we propose a method of evaluating \( \pi_0^B \) and \( \pi_0^P \) analytically based on the return rate of dead stock. The return rate can be evaluated as follows:

\[
R(q) = \frac{I(q)}{q} = \frac{\int_0^q F(x)dx}{q}. \tag{9}
\]

The return rate at present is approximately 40 percent. Then, the trading quantity is given as \( q \) such that satisfies \( R(q) = 0.4 \). Particularly, this trading quantity is denoted by \( q_0 \).

The relation of \( k_0 = k_w \equiv k_n \) is realized under the consignment sale system. Hence, the profit \( \pi_0^B \) of bookstore under the consignment sale system is obtained as follows:

\[
\pi_0^b = (1 - k_n - k_c)r q_0 - (1 - k_n)r \int_0^{q_0} F(x)dx, \tag{10}
\]

where it is approximately \( k_n = 0.8 \) under the present consignment sale system. Similarly, we formulate the profit of publisher. The profit \( \pi_0^p \) of publisher at the present consignment sale system is given as follows:

\[
\pi_0^p = (k_n - k_c)q_0 - (k_n + k_c)r \int_0^{q_0} F(x)dx. \tag{11}
\]

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In order to understand the incentive compatible condition, we have a numerical example. Particularly, we assume a magazine as a publication. Then, the retail price is given as \( r = 200 \) (yen). The cost coefficients except \( k_n \) and \( k_c \) are as follows: \( k_n = 0.35 \), \( k_c = 0.05 \), and \( k_l = 0.05 \). Also, \( k_{low} = 0.8 \) is given as mentioned above. Then, the demand distribution is given as the normal distribution with \( \mu = 100 \) and \( \sigma^2 = 15^2 \). Further, the following results are obtained from \( R(q_0) = 0.4 \):

\[
\begin{align*}
q_0 &= 166.67, \\
\pi_0^B &= 2333.33, \\
\pi_0^P &= 3666.65.
\end{align*}
\]

Fig.1 shows the combination of \( k_w \) and \( k_b \) satisfying the incentive compatible condition in Eq.(8). Precisely, the incentive compatible condition is given as a gray area composed of one line and two curves. The combination of \( k_w \) and \( k_b \) is a minimum necessary condition to realize the shift from the consignment sale system to the responsible sale system.

4. Collaborative Coordination

In the previous section, we have shown any combinations of \( k_w \) and \( k_b \) which have the possibility of realizing the shift from the consignment sale system to the responsible sale system. At least, the contract parameters have to be selected among some combinations of \( k_w \) and \( k_b \) satisfying Eq.(8), i.e., the incentive compatible condition. Further, we discuss the solution from the contract condition to be satisfied.

As mentioned already, the trading quantity is given as \( q^B \) in Eq.(4) from the decision-making of bookstore. This result is based on the request of bookstore. On the other hand, consider the request of publisher. By differentiating Eq.(5) with \( q \), the trading quantity where the publisher hopes to sell publications to the bookstore is given as follows:

\[
F(q^P) = \frac{k_w - k_c}{k_b - k_c}. \tag{12}
\]

On concluding the contract collaboratively under the responsible sale system, the agreement between both is needed. We consider the relationship \( q^B = q^P \) as one form of collaborative agreement. Then, the combinations of \( k_w \) and \( k_b \) such that \( q^B = q^P \) is considered. From Eqs.(4) and (12), the following relation with respect to \( k_w \) and \( k_b \) is obtained:

\[
k_w = (1 - k_n) - \frac{(1 - k_c - k_n)(1 - k_b)}{1 + k_c}. \tag{13}
\]

Fig.2 shows a numerical example in Eq.(13), where the setting of parameters is same as Fig.1. The combinations of \( k_w \) and \( k_b \) satisfying Eqs.(8) and (13) have the possibility to lead to the contract conclusion. In other words, the rational combinations of \( k_w \) and \( k_b \) are given on the linear function in the area of incentive compatible condition. Unfortunately, the unique solution to contract conclusion is not shown yet.

By the way, there is a coordination approach as one of concepts for obtaining a solution on decision-making in supply chain contract. The traditional coordination approach aims at the total optimization in whole supply chain at first [6],[7]. For comparison, we apply the traditional coordination approach to the model.

The profit function in the whole supply chain is defined as follows:

\[
\pi^W = \pi^p + \pi^b = (1 - k_c - k_n)rg - (1 + k_c)\int_0^q F(x)dx. \tag{14}
\]

Then, the optimal trading quantity of whole supply chain is obtained as follows:
\[
F(q^W) = \frac{1 - k_c - k_d}{1 + k_a}.
\] (15)

On the traditional coordination in bargaining process leading to the contract conclusion referred by Tsay et al. [6] and Cachon and Lariviere [7], the relation of leader and follower is assumed. The real decision-maker is considered to be a leader. Hence, the optimal solution in the whole supply chain is equalized to that of leader. The leader controls the follower’s behavior such that the optimal solution of leader is realized.

In the model, the bookstore and publisher are corresponding to follower and leader, respectively. The bookstore is a decision-maker for the trading quantity \( q \) and then the publisher is also a real decision-maker for the contract parameters \( k_a \) and \( k_b \). In other words, the publisher determines \( k_a \) and \( k_b \) such that the optimal quantity \( q^W \) determined by the bookstore is equal to \( q^W \) in the optimization of whole supply chain. Hence, the traditional coordination approach aims at the relation \( q^W = q^H \). Especially, it should be paid attention to that the bookstore does not aim at the whole optimization in general. Interestingly, the combinations of \( k_a \) and \( k_b \) with \( q^W = q^W \) is the same as those of Eq.(13). Also, we obtain the same result in the case of \( q^W = q^W \). Note that the result is same but the idea is different. In this paper, our approach is called the collaborative coordination approach for distinction with the traditional coordination approach. Similar to the traditional coordination approach, the collaborative coordination approach realizes the optimization of whole supply chain. Under the setting of parameters in Fig.2, \( q^W \) and \( \pi^W \) are obtained as follows:

\[
\begin{align*}
q^W &= 102.70, \\
\pi^W &= 10763.53.
\end{align*}
\]

Fig. 2 Collaborative Coordination between Publisher and Bookstore

5. Bargaining Solutions

In this section, we discuss the method of obtaining a unique solution to the contract problem. Nash defined a two-person bargaining problem, and looked for a bargaining solution as the resulting payoff allocation that each of participants unanimously agrees upon. Therefore, the cooperative bargaining process initiated by Nash [8],[9] is applied to obtaining a unique solution to the contract problem in the model.

Under the concept of the cooperative bargaining process initiated by Nash [8],[9], the following objective function is defined in the model:

\[
T = [\pi^P(k_a, k_b) - \pi^P_0] [\pi^B(k_a, k_b) - \pi^B_0],
\] (16)

where a pair of profits of publisher and bookstore under consignment sales system can be defined as the disagreement point of bargaining. The bargaining solution is obtained as \((k_a, k_b)\) maximizing the function \( T \) in Eq.(16).

The function \( T \) is a function of \( k_a \) and \( k_b \) from Eqs.(6) and (7). Remark that the trading quantity between publisher and bookstore is \( q^B \) in Eq.(16). From Eq.(4), we obtain

\[
k_w = 1 - k_c - (1 - k_b)F(q),
\] (17)

where \( q^B \) is denoted by \( q \) for simplification. By substituting the relation in Eq.(17) into Eq.(16), the function \( T \) is transformed into a function of \( q \) and \( k_b \) as follows:

\[
T = [\pi^P(q, k_b) - \pi^P_0] [\pi^B(q, k_b) - \pi^B_0],
\] (18)

By differentiating partially \( T \) in \( q \) and \( k_b \), we obtain the following relations:

\[
\frac{\partial T}{\partial q} = \frac{\partial \pi^B(q, k_b)}{\partial q} [\pi^B(q, k_b) - \pi^B_0] + [\pi^B(q, k_b) - \pi^B_0] \frac{\partial \pi^P(q, k_b)}{\partial q},
\] (21)

\[
\frac{\partial T}{\partial k_b} = \frac{\partial \pi^B(q, k_b)}{\partial k_b} [\pi^B(q, k_b) - \pi^B_0] + [\pi^B(q, k_b) - \pi^B_0] \frac{\partial \pi^P(q, k_b)}{\partial k_b}.
\] (22)

The bargaining solution \((q^*, k_b^*)\) is given by the first order condition of differentiation.

From Eq.(22) and the following relation:

\[
\frac{\partial \pi^P(q, k_b)}{\partial k_b} = \frac{\partial \pi^B(q, k_b)}{\partial k_b}
\]

we obtain the following relation with respect to \((q^*, k_b^*)\):

\[
\pi^B(q^*, k_b^*) - \pi^B_0 = n^* - \pi^B_0.
\] (24)

Then, Eqs.(21) and (24) lead to the following relation:

\[
\left\{ \frac{\partial \pi^B(q, k_b)}{\partial q} + \frac{\partial \pi^B_S(q, k_b)}{\partial q} \right\}_{(q, k_b)=(q^*, k_b^*)} = 0.
\] (25)

As a result, we have the Nash bargaining solution from the relations of Eqs.(24) and (25). Note that Eq.(25) is equivalent to the first order condition in the optimization of Eq.(14). Hence, \( q^* = q^W \) is obtained from Eq.(25). This result is rational in
the point that the result of bargaining leads to the optimization in the whole supply chain. Also, it is noted in Eq.(24) that the incremental profit is equally divided between the publisher and bookstore. This result is one of contract conditions to be satisfied on the agreement between publisher and bookstore.

Fig. 3 shows a numerical example of the Nash bargaining solution between publisher and bookstore, where the setting of parameters is same as Figs.1 and 2. This bargaining solution satisfies the results of incentive compatible condition and collaborative coordination. Then, we have shown the solution with the contract condition to be satisfied in the agreement between publisher and bookstore. The numerical results are as follows:

\[
\begin{aligned}
(k^1_w, k^1_b) &= (0.687, 0.540), \\
q^1 &= 102.70, \\
\pi^P(k^1_w, k^1_b) &= 6047.85, \\
\pi^B(k^1_w, k^1_b) &= 4715.68.
\end{aligned}
\]

Then, the return rate of publications is \( R(q^W) = 0.072 \), in other words, approximately 7%.

![Nash Bargaining Solution between Publisher and Bookstore](image)

Finally, we provide the additional discussion of bargaining solution. The general bargaining solution [10],[11] has been proposed as the extension to the Nash bargaining solution [8],[9]. The general bargaining solution takes the difference between players such as scale and capital into consideration. Concretely, the general bargaining solution is provided by the following general objective function:

\[
T_q = \left[ \pi^P(k^*_{w}, k^*_{b}) - \pi^P_0 \right]^\alpha \left[ \pi^B(k^*_{w}, k^*_{b}) - \pi^B_0 \right]^\beta,
\]

where \( \alpha + \beta = 1 \), and then \( \alpha \) and \( \beta \) denote the parameters for power balance. Throughout similar procedures, we have the following relations with general bargaining solution \( (q^*, k^*_w) \):

\[
\begin{aligned}
\alpha \left[ \pi^B(q^*, k^*_w) - \pi^B_0 \right] &= \beta \left[ \pi^P(q^*, k^*_b) - \pi^P_0 \right], \\
\left\{ \frac{\partial \pi^B(q, k_b)}{\partial q} + \frac{\partial \pi^P(q, k_w)}{\partial q} \right\}_{(q, k)=(q^*, k^*_b)} &= 0.
\end{aligned}
\]

It is noted in Eq.(27) that the incremental profit is divided between the publisher and bookstore in the ratio of \( \alpha : \beta \). Also, Eq.(28) leads to the same result as Eq.(25).

As mentioned already, \( \alpha \) and \( \beta \) is determined by the difference between publisher and bookstore, i.e., such as scale and capital. However, the objectivity of index might be lacked when the index is determined using the information except contract. So, we propose how to decide the value of \( \alpha \) and \( \beta \) as follows:

\[
\begin{aligned}
\alpha &= \frac{\pi^P_0}{\pi^P_0 + \pi^B_0}, \\
\beta &= \frac{\pi^B_0}{\pi^P_0 + \pi^B_0}.
\end{aligned}
\]

We think that a certain degree of objectivity is realized by our proposal.

Table 1 shows the comparison between the usual and general Nash bargaining solutions, where the setting of parameters is same as previous figures. From the setting of \( \alpha \) and \( \beta \), the changes of \( k^*_w, k^*_b, \pi^P(k^*_w, k^*_b) \) and \( \pi^B(k^*_w, k^*_b) \) are found. The other numerical results are as follows:

\[
\begin{aligned}
\alpha &= 0.611, \\
\beta &= 0.389.
\end{aligned}
\]

### 6. Concluding Remarks

This paper has considered the transaction of publications under the responsible sale system in the publishing supply chain in Japan. Especially, we have discussed the sale contract to realize the shift from the consignment sale system to the responsible sale system.

At first, the model has been formulated according to the present responsible sale system. In the model, we have considered the responsible sale system to be a kind of contract between publisher and bookstore. Then, the necessary condition of the wholesale and buyback prices as contract parameters to realize the shift from the consignment sale system to the responsible sale systems, i.e., the incentive compatible condition, has been shown. Next, we have proposed the new coordination approach, i.e., the collaborative coordination approach, to satisfy the respective requests of publisher and bookstore collaboratively for obtaining the agreement between publisher and bookstore. At the same time, the relationship to the traditional coordination approach has been discussed. Further, the method of obtaining the bargaining solution has been provided in order to conclude the contract. Particularly, the feature of this study is that a unique solution has been obtained by piling up the contract condition to be satisfied.

The publishing industry in Japan is facing to a turning point. As mentioned in section 1, in the trial practice of the responsible sale system in the real publishing supply chain, the wholesale price to bookstore is approximately 65% of retail price and the buyback price is approximately 35% of retail price [3],[4]. There may be somewhat difference between this trial condition and the result of this study, i.e., see Fig.3 and Table 1. Particularly, we can find the large difference between the buyback
prices in the trial condition and the result in this study. The actual operation in the trial practice of the responsible sale system is proceeding based on the initiative of publisher. In other words, the present trial practice is not a result of collaboration between publisher and bookstore. Naturally, the compatibility of incentives may be nonexistent. The large difference between the buyback prices mentioned before may indicate this nonexistence of the collaboration between publisher and bookstore. That is, because the present trial practice is operated by the initiative of publisher, the profit of the bookstore may not be considered by the publisher sufficiently. From this fact, it is concluded that this study about the contract problem based on the collaboration between publisher and bookstore is valuable in order to promote the rational spread of the new responsible sale system. Further, in this study, the opportunity loss has been not considered yet. The present result in this study will be refined by introducing the opportunity loss. Also, various discussions of sale systems will be needed. We are willing to proceed with the further research.

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