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ELECTRONIC MARKET PLACE FOR RETURNED PRODUCTS IN THE PUBLISHING INDUSTRY: A SIMULATION ANALYSIS

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ABSTRACT

In the publishing industry, the publishers supply products like the magazines, newspapers and books to the retailers. In order to encourage the retailers to order more, the publishers usually adopt a kind of buy-back return policies under which the retailers can return the unsold products for a partial refund. In the past, due to the lack of retail sales channel, most of the returned products were salvaged at a very low value. Now, with the advance of e-commerce, publishers can make use of Internet as an e-marketplace to sell those returned products to a completely different market – the World Wide Web. Since Internet offers a global open system, it breaks the geographical barrier and the demand for those "locally fade-out" goods can be very significant. In light of this, we study in this paper a two-echelon supply chain with one publisher and multiple retailers. Through the simulation analysis, we find that the impact of the e-marketplace can be substantial. Depending on the operations cost of the e-marketplace and the size of the demand, the expected profit improvements for the publisher, the retailers and the overall supply chain vary. We identify the factors that can achieve the situation under which all parties' profits are improved with the e-marketplace. Moreover, with a price dependent demand distribution for the e-marketplace, we can determine the optimal buy-back price and the optimal e-marketplace selling price for the product. A real case of a local publisher has been chosen for simulation analysis and the managerial issues are discussed.

INTRODUCTION

We are now in the information age. With a continuous decrease in prices of computers and Internet access services, going online is not a luxurious activity anymore. With the popularity of Internet and the growing confidence about the reliability and security of the network, e-commerce has a bright future. Nowadays, companies can contact their customers and business partners, place orders and finish transactions anywhere via Internet. From a supply chain operational perspective, it is generally believed that Internet can help improve the supply chain's efficiency. In fact, one of the proposal is to use Internet to solve the channel coordination problem in supply chain management (e.g. achieving the virtual vertical integration).

With the practical importance of Internet, many articles have appeared in recent supply chain management literature. Let us share and review some of them now. First, in [8], many applications of Internet for supply chain management have been identified. The authors start the discussion with a review of Internet's features and its role in the supply chain management. They mention the issues of efficient information flow, virtual integration and strategic gaming among members of the supply chain. They then discuss the direct sales and the e-marketplace sales channels via Internet. For the e-marketplace, they find that the aggregation of buyers and sellers on the e-marketplace can lead to lower transaction costs and a more efficient market information flow. It also facilitates B2B transaction. Moreover, in inventory management, manufacturers can also buy inventory from other suppliers and sell the excess capacity or inventory via the e-marketplace. Besides e-marketplace, the applications of auctions and bidding on Internet with industrial examples and figures are outlined. In fact, [8] gives us an insightful overview for many issues which builds the conceptual framework for further quantitative analysis of supply chain management with Internet.

The potential applications of Operations Research (OR) techniques in the e-marketplace and Internet enabled supply chain systems are proposed in [15]. The author has mentioned the technological issues of the e-marketplace and the OR opportunities there. In his analysis, the firm's planning horizon is separated into four categories: Long term, medium term, short term and immediate. For each category, he describes the corresponding business drivers and suggest the possibilities for applying OR skills to deal with each one of them. He believes that the supply chains with Internet and the e-marketplaces can let companies get additional benefits by using OR. This paper provides us a lot of information about how to apply OR methods, together with Information Technology, for solving real-life problems.

In the earlier time, the idea of frictionless competition on Internet is investigated in [1]. The authors have made a comparison between the conventional retailers and the e-tailers. They carried out empirical studies towards the price adjustment and dispersion of the e-tailers and conventional store retailers of CDs and books. They conclude by saying that although internet competition exhibits lower friction, attributes like branding, trust and awareness exist and differentiate different e-tailers from one another. Other interesting e-commerce related articles for operations management include [4], [5] and [7].

In this paper, instead of proposing a conceptual framework, we formulate a quantitative model and provide a simulation analysis about the use of e-marketplace for selling returned products in the publishing industry. We consider a two-echelon supply chain with a single publisher who supplies the products to multiple retailers. It is a usual practice in the publishing industry that the publisher will adopt a buy-back return policy. Under this buy-back policy, the retailers can return the excessive orders (i.e. the unsold products at the end of the season) to the publisher for a partial refund. This type of policy with different extensions has been widely studied in the literature ([2], [3], [6], [10], [11], [13] and [16]). Notice that the first well-recognized quantitative analysis of buy-back contract appears in the marketing science literature by Pasternack [13]. Back to the discussion of the return policy in the publishing industry, under the original practice, the publisher uses a buy-back policy to attract the retailers to order more while the returned products (from the retailers) usually worth very little to the publisher (e.g. just the value of the paper for recycling). Now, with the advance of e-commerce, we propose that the publisher can sell the returned products at a nicer price (higher than the salvage value) on the e-marketplace. In this paper, we look into this issue and through simulation analysis, we first determine the optimal buy-back price in the absence of the e-marketplace. Then, we will find the optimal buy-back price and the optimal selling price of the returned products in the e-marketplace. After that, we study the impacts brought by the e-marketplace to the publisher, the retailers and the overall supply chain. Numerical analysis is carried out and managerial insights are then developed.

The organization of the rest of this paper is as follows: We first propose the basic model and then we derive the mathematical details for all the parties in the supply chain. Afterwards, a real case is studied and simulation analysis for the supply chain with and without the e-marketplace is done. Numerical analysis towards the parameters of the e-marketplace is carried out, too. Finally, we conclude with a discussion and managerial insights are developed.

BASIC MODEL

In this paper, we propose a two-echelon supply chain for a certain publishing business. We consider a publisher who supplies a single product to multiple retailers. This product can be a magazine, a journal or a book, etc. The normal selling season of this product is short. For example, for the bi-weekly magazine, its normal selling season is just about two weeks. At the end of the selling season, the retailers can return the unsold products to the publisher following a buy-back return policy. To be specific, this return policy states that the unsold products can be returned to the publisher for a partial refund with a unit buy-back price b. For example, suppose a publisher sells the products to the retailers with a unit wholesale price of $100 and set the unit buy-back price to be $40. Then after the selling season, the retailers can return the unsold products to the publisher and the publisher will pay $40 for each returned product. In this paper, we only consider a flat rate of buy-back price, i.e. the buy-back price is fixed and it does not depend on the returned and order quantities. Moreover, owing to the legal issue of fairness, the unit buy-back price b offered by the publisher must be the same for all retailers (see [16]). In the old practice without the e-marketplace, the publisher would salvage the returned products at a unit salvage price v. Now, with Internet, the publisher can consider selling the returned products with a nicer price (higher than the salvage price) through Internet. This is an example of using Internet as a market place for excess products as mentioned in [8].

Now, for the product's cost and revenue structure, we assume that the product has a fixed market retail selling price r for all retailers during the normal selling season. Examples of this type of products include magazines, newspapers, journals, standard priced books, etc with which the publisher sets a recommended price. For the retailers, the unit ordering cost of the product from the publisher is c. Following the buy-back return policy, the unsold product can be returned to the publisher at a unit price b at the end of the selling season. The unsold product also incurs a unit holding cost h. In the inventory literature, the unit holding cost (per unit time period) is taken to be a product of the unit ordering cost c and a constant accounting factor I, where $0 < I \le 1$. For simplicity, we assume I to be fixed and every retailer has a unit holding cost h. For the publisher, the production cost is m per item. After the retailers have returned the unsold products, the publisher can sell them to the salvage market at a unit price of v. Since the wholesale price of the product is c and the salvage value is v, the buy-back price under our consideration lies between them: $v \le b < c$. Besides salvaging the returned products at a low salvage value, the publisher can also consider selling these products in the e-marketplace with a unit selling price of r_{EMP}. Obviously, we have $r_{EMP} > v$ or else it is unwise to sell through the e-marketplace. By the way, if the publisher chooses to sell the returned products through the e-marketplace and some products cannot be sold finally, it will incur an additional unit holding cost of h_{EMP} but it can still be sold to the salvage market. Moreover, in order to use and establish the e-marketplace, the publisher needs to pay a fixed operational cost of C_{EMP}. In this paper, there are n retailers and 1 publisher (the sole supplier of the product). During the normal selling season, the market demand for the product faced by retailer i is called x_i. The probability density function (pdf) and the cumulative distribution function (cdf) for x_i are represented by $g_i(x_i)$ and $G_i(x_i)$, respectively. In this paper, these distributions are assumed to be independent of one another and we assume them to be *normal distributions*, i.e.,

$$x_i \sim N(m_i, s_i^2)\,. \qquad (1)$$

Moreover, we represent the standard normal pdf and cdf by $f(\cdot)$ and $\Phi(\cdot)$, respectively. The inverse function of $\Phi(\cdot)$ is denoted by $\Phi^{-1}(\cdot)$.

After the normal retail selling season, if the publisher uses the e-marketplace for selling the returned products, the corresponding market demand is called x_{EMP}. Since x_{EMP} obviously depends on the selling price of the product in the e-marketplace (r_{EMP}), we treat it as a price dependent variable with the following structure: When r_{EMP} is well-bounded, $\underline{r}_{EMP} \le r_{EMP} \le \bar{r}_{EMP}$, the distribution of x_{EMP} is as follows:

$$x_{EMP} = -K_1 r_{EMP} + K_2 + e_{EMP}\,, \qquad (2)$$

where K_1, K_2 are positive constants and e_{EMP} is a random variable distributed as a normal distribution with zero mean and constant variance:

$$e_{EMP} \sim N(0, s_{EMP}^2)\,. \qquad (3)$$

Notice that the above demand distribution follows the well-known linear price dependent demand distribution model in the literature (see [9]). Observe that the product under our consideration has a fixed retail price in the retail market during the normal selling season. Thus, we do not explicitly formulate a price dependent demand distribution for the retail demand x_i.

Moreover, notice that in this model, we assume that the existence of the e-marketplace for the returned products does *not* affect the original retail market. The reasons for that include:

1. From the time the products are returned from the retailers to the publisher, it already takes a relatively long time. For instance, for a monthly magazine, suppose it appears in the retail shop on Day 1. After the normal selling season of a month (and probably 1 or 2 weeks more), the retailers will call the publisher to pick up the unsold magazines. However, the publisher may only pick them up during the time when his truck visits the retailer for new product's delivery (i.e. at the end of the month). After picking up and collecting all the returned products from the retailers, the publisher can then decide the other related operations issues for selling the magazines through the e-marketplace. So, in this example, the returned magazine will be available in the e-marketplace after two months from Day 1. So, consumers who can buy and want to buy the magazine during the normal selling season is unlikely to wait that long for the magazine.
2. Notice that the purchase of the "fade-out" products in the e-marketplace incurs an explicit delivery cost. For the consumers, they may have to pay the delivery cost of the products. Thus, the overall expenses for buying the products through the e-marketplace are not necessarily lower than the retail selling prices of the products during the normal selling season. In this case, the shift of the market demand due to the existence of the e-marketplace for the returned goods is insignificant.

3. The product under our investigation is a short-life product, most of the consumers in its retail market are not interested about it after the normal selling season. For example, for the weekly fashion magazine, most of us are only interested in buying the latest issue and not the old ones. However, the returned products may have values to people overseas or people who cannot buy the products at the first instance (e.g. due to the geographical barrier). Since e-marketplace is open to everywhere, the demand for the product in a global sense can be substantial.

With all these details, Figure 1 shows the basic model of the problem. The sequence of the events in Figure 1 are numbered and they are: First, the publisher supplies the product to the retailers. After the normal selling season, the products leftover are then returned to the publisher. Next, the publisher sells the returned product through the e-marketplace (EMP). After the end of the sales via the e-marketplace (EMP), any unsold products are salvaged. Notice that in Figure 1 and the rest of this paper, *EMP stands for the e-marketplace*.

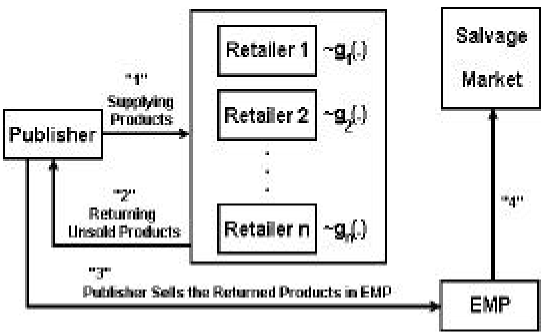

Figure 1: The basic supply chain model with the e-marketplace.

In the next section, we will present the mathematical details of the single-publisher multi-retailer supply chain as shown in Figure 1.

MATHEMATICAL STRUCTURES

We first derive the profit expressions for the retailer and the publisher. Here we have multiple retailers and we call them Retailers 1, 2, …, n, respectively. We denote order quantity and the corresponding profit for Retailer i (i = 1, 2, …, n) by $q_{retail,i}$ and $p_{retail,i}(q_{retail,i})$, respectively. When the buy-back price b is given, the profit for Retailer i with order quantity $q_{retail,i}$ is as shown below:

$$\begin{aligned} p_{retail,i}(q_{retail,i}) &= r\min(q_{retail,i}, x_i) - cq_{retail,i} \\ &\quad + (b-h)\max(0, q_{retail,i} - x_i) \\ &= (r-c)q_{retail,i} \\ &\quad - (r+h-b)\max(0, q_{retail,i} - x_i), \quad (4) \end{aligned}$$

where the second equality is obtained by using the relationship of $\min(q_{retail,i}, x_{retail,i}) = q_{retail,i} - \max(0, q_{retail,i} - x_{retail,i})$. Taking expectation of (4) with respect to x_i, the expected profit becomes,

$$\begin{aligned} EP_{retail,i}(q_i) &= (r-c)q_{retail,i} \\ &\quad - (r+h-b)E\{\max(0, q_{retail,i} - x_i)\} \\ &= (r+h-b)m_i - (c+h-b)q_{retail,i} \\ &\quad - (r+h-b)s_i\Psi[(q_{retail,i} - m_i)/s_i], \quad (5) \end{aligned}$$

where $\Psi(\cdot)$ is the right linear loss function for standard normal and it is defined as follows:

$$\Psi(y) = \int_y^{\infty}(t-y)d\Phi(t). \quad (6)$$

On the other hand, for Retailer i with order quantity $q_{retail,i}$, we denote the product left-over at the end of the selling season by $L_{retail,i}(q_{retail,i})$. The expected product left-over at the end of the selling season with order quantity $q_{retail,i}$ can be derived to be the following:

$$\begin{aligned} EL_{retail,i}(q_{retail,i}) &= [q_{retail,i} - m_i] + s_i\Psi[(q_{retail,i} - m_i)/s_i]. \quad (7) \end{aligned}$$

By checking the second order derivative of $EP_{retail,i}$, we find that $EP_{retail,i}$ is a concave function. As a result, the order quantity $q^*_{retail,i}$ which maximizes $EP_{retail,i}$ can be found easily by solving $dEP_{retail,i}(q_i)/dq_i = 0$:

$$q^*_{retail,i} = m_i + s_i\Phi^{-1}\left(\frac{r-c}{r+h-b}\right). \quad (8)$$

Notice that the above result basically follows the classical newsvendor model. In the following, we derive the expected profits for the publisher under the case without and with the use of the e-marketplace.

Without EMP:

When the publisher does not sell the returned product on Internet, the expected profit of the publisher is derived to be:

$$EP_{Publisher,EMP-} = (c-m)\sum_{i=1}^{n} q_{retail,i} - (b-v)\sum_{i=1}^{n} EL_{retail,i}(q_{retail,i}). \quad (9)$$

Notice that $\sum_{i=1}^{n} EL_{retail,i}(q_{retail,i})$ represents the total expected quantity of returned products from the retailers back to the publisher. The publisher's expected profit with the retailers' optimal order quantities written as a function of b, $EP^*_{Publisher,EMP-}(b)$, is found by putting (8) into (9):

$$EP^*_{Publisher,EMP-}(b) = (c-m)\sum_{i=1}^{n} q^*_{retail,i} - (b-v)\sum_{i=1}^{n} EL_{retail,i}(q^*_{retail,i}). \quad (10)$$

With (10), the optimal buy-back price for the publisher (when there is no EMP), b^*_{EMP-}, is determined by maximizing $EP^*_{Publisher,EMP-}(b)$:

$$b^*_{EMP-} = \arg_b \{\max EP^*_{Publisher,EMP-}(b)\}. \quad (11)$$

Since the buy-back price is bounded between the salvage value v and the product's wholesale price c, b^*_{EMP-} can be found by a simple numerical search.

With EMP:

Similar to the case without EMP, when the publisher sells the returned product on Internet, the publisher's profit, $P_{Publisher,EMP+}$, is derived to be:

$$\begin{aligned} P_{Publisher,EMP+} &= (c-m)\sum_{i=1}^{n} q_{retail,i} - b\sum_{i=1}^{n} L_{retail,i}(q_{retail,i}) \\ &+ r_{EMP}\min(x_{EMP}, \sum_{i=1}^{n} L_{retail,i}(q_{retail,i})) \\ &- (h_{EMP}-v)\max(0, \sum_{i=1}^{n} L_{retail,i}(q_{retail,i}) - x_{EMP}) \\ &- C_{EMP}. \end{aligned}$$

Denote:

$$SL = \sum_{i=1}^{n} L_{retail,i}(q_{retail,i}). \quad (12)$$

Since min(X, Y) = X – max(0, X – Y), we have:

$$\begin{aligned} P_{Publisher,EMP+} &= -(r_{EMP}+h_{EMP}-v)\max(0, SL - x_{EMP}) \\ &+ (c-m)\sum_{i=1}^{n} q_{retail,i} \\ &+ (r_{EMP}-b)SL - C_{EMP}. \end{aligned} \quad (13)$$

Taking expectations of (13) w.r.t. SL and x_{EMP}, we have:

$$\begin{aligned} EP_{Publisher,EMP+} &= (r_{EMP}-b)\sum_{i=1}^{n} EL_{retail,i}(q_{retail,i}) \\ &- (r_{EMP}+h_{EMP}-v)\int_0^{\sum_{i=1}^{n} q_{retail,i}} G(SL) f_{SL}(SL)\,dSL \\ &+ (c-m)\sum_{i=1}^{n} q_{retail,i} - C_{EMP}, \end{aligned} \quad (14a)$$

where

$$G(SL) = \int_{-\infty}^{SL} [SL - x_{EMP}] f_N(x_{EMP})\,dx_{EMP}. \quad (14b)$$

In (14a), $f_{SL}(SL)$ is the probability density function for SL; in (14b), $f_N(x_{EMP})$ is the probability density function for x_{EMP} which is also a normal density. Observe that with EMP, instead of directly salvaging the returned products, the publisher acts like a "retailer" and sells on the e-marketplace and generates profit. Substituting the optimal Retailer i's order quantity into (14a) and (14b), we yield the publisher's expected profit in the following:

$$EP^*_{Publisher,EMP+} = EP_{Publisher,EMP+}(q_{retail,i} = q^*_{retail,i}). \quad (15)$$

With (15), since r_{EMP} and b are both well-bounded in our model formulation, the optimal solution pair of r^*_{EMP} and b^*_{EMP+} can be found by numerical searches:

$$(r^*_{EMP}, b^*_{EMP+}) = \arg\{\max EP^*_{Publisher,EMP+}\}. \quad (16)$$

Notice that the expected profit expressions in (14) and (15) cannot be further simplified. In general, since we do not have a nice analytical closed form expression for the distribution of the total retail returned product quantities SL, we do not have a nice closed form expression for $EP^*_{Publisher,EMP+}$ as well. In this case, instead of seeking for the analytical closed form solution, we carry out simulation experiments and get the optimal buy-back and the optimal e-marketplace selling price for the returned products numerically.

SIMULATION ANALYSIS – A CASE STUDY

We carry out in this section a simulation analysis towards a real case in Hong Kong. A publisher in Hong Kong publishes a funny book series with the main themes about some popular people in Hong Kong, including the government officials and famous business merchants. The publisher publishes about 6 funny books a year and they supply the books to hundreds of major retailers in Hong Kong.

The sales of the three most recent publications are 40000, 20000 and 35000 copies, respectively. The recommended unit retail selling price of the funny book is HK$25 and it is reported that the publisher can earn approximately half of all the revenue. This publisher has used the buy-back return policy to entice the retailers to order more. According to the previous experience, the normal selling season of each edition of the funny book series is about 1 to 2 months. After that, the retailers can return the books to the publisher for partial refund. Since the retail market is highly volatile and the overall demand is substantial, the amount of returned books is not trivial. (Remarks: The empirical details and some of the data of this case are found from the interview of the publisher in a local magazine [12]).

In light of the background of this publisher, we would like to formulate a model for the publisher using the model structure we have presented in the previous section. From the information we have (Ref.: [12]), we have estimated that the current unit production cost for the book, *m*, is $4. The unit wholesale price for the magazine, *c*, is $16 and the publisher has marked the recommended unit retail selling price of the magazine, *r*, to be $25. The annual holding rate I is 2% and the holding cost for each unsold magazine at the end of each month is calculated to be $(2\% \times \$16)/12$ = $0.0267.

Currently, the publisher supplies the magazine to about 400 major retailers around Hong Kong (and they will split the orders to other smaller newsvendors, etc). We categorize these 400 retailers into three groups: The high demand, medium demand and low demand groups, respectively. The demand distributions for high, medium and low demand groups are as shown below:

$$x_{High} \sim N(210, 70^2), \qquad (17)$$

$$x_{Medium} \sim N(60, 20^2), \qquad (18)$$

$$x_{Low} \sim N(15, 5^2). \qquad (19)$$

Notice that the uncertainties for all of these demands are the same in the sense that they have the same coefficient of variation: "standard deviation /mean" = 1/3. We also assume the number of retailers with high, medium and low demands to be 80 (20%), 240 (60%) and 80 (20%), respectively.

With all these details, we can start our simulation studies. During the simulation, demands for retailers following (17), (18) and (19) are randomly generated and the corresponding expected profits are found. All simulation results are obtained after running simulation experiments for 500 times. For the case with EMP, the optimal buy-back and the optimal EMP selling price are found with 1 decimal place of accuracy. In Table 1, we list the average profits for the publisher, all the retailers and the supply chain with different values of buy-back price *b* under the case without EMP. Notice that the average profit of the supply chain is equal to the summation of the publisher's and retailers' average profits. Moreover, searching for the optimal buy-back price which maximizes the publisher's average profit numerically, we have: b = 11.0 and the corresponding average profits for the publisher, the retailers in total and the supply chain are 363447, 234493 and 597940, respectively. By the way, if we search for the optimal buy-back price which maximizes the average profit of the supply chain, we have: b = 14.3 and the corresponding average profits for the publisher, the retailers in total and the supply chain are 350805, 262996 and 613801, respectively

Notations:
PAP = Publisher's average profit.
RAP = Retailers' average profit in total.
SAP = Supply-chain's average profit.
CAP = Change of average profit.
%CAP = Percentage change of average profit.
AP = Average profit.
K = 1000 (Kilo).
m = 0.001.

Table 1: The average profits of the publisher, retailers and the supply chain with different buy-back price b when there is no EMP.

b	PAP	RAP	SAP
0.01	342261	189921	532182
1	344564	192609	537173
2	346909	195492	542401
3	349262	198563	547825
4	351606	201851	553457
5	353916	205383	559299
6	356154	209187	565341
7	358274	213315	571589
8	360203	217826	578029
9	361835	222793	584628
10	363004	228306	591310
11	363447	234493	597940
12	362734	241549	604283
13	360084	249761	609845
14	353864	259605	613469
15	339642	272047	611689
15.9	295209	287934	583143

Findings 1: (From Table 1)

1. In Table 1, we can observe that when the buy-back price increases, the total retailers' average profit increases. It meets our intuition as the retailers can return their products with a nicer return price.

2. In the case without EMP, the publisher's optimal buy-back price
3. (11.0) is not equal to the supply chain's optimal buy-back price (which we have found to be 14.3). It means that the supply chain is not optimal and double marginalization occurs. This is due to the fact that there is no coordination and integration between the publisher and the retailers in our model.

Now, we consider the use of e-marketplace. Following (2) and (3), suppose the e-marketplace has the following price-dependent demand structure for all $12 \le r_{EMP} \le 25$ (P.S: Here, we only consider the values of r_{EMP} which range from about 50% to 100% of the retail market price):

$$x_{EMP} \sim N(-K_1 r_{EMP} + K_2, s^2_{EMP}) , \quad (20)$$

where r_{EMP} is the unit product's selling price via the e-marketplace and K_1, K_2, s_{EMP} are all known constants. Moreover, notice that r_{EMP} is bounded while x_{EMP} is a normally distributed random variable which is not well-bounded. In order to study the effect of high and low demand in the e-marketplace, we carried out simulation experiments with different values of these parameters while we have kept the coefficient of variation (standard deviation/mean) fixed. Tables 2.1, 2.2, ..., 2.6 show the optimal buy-back price with different values of r_{EMP} and the corresponding average profits for the publisher, the retailers and the supply chain. Notice that we have not included the fixed operations cost of the EMP in the simulation results.

Table 2.1: With Case 1 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 1: $x_{EMP} \sim N(-300\ r_{EMP} + 12000 , 2400^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	13.5	452269	254436	706705
13	13.5	457279	254436	711715
14	13.5	461716	254436	716152
15	13.4	465602	253464	719066
16	13.4	468920	253464	722384
17	13.3	471651	252512	724163
18	13.2	473787	251577	725364
19	13.1	475324	250661	725985
20	13.0	476266	249761	726027
21	12.9	476621	248878	725499
22	12.7	476365	247156	723521
23	12.7	475525	247156	722681
24	12.5	474129	245489	719618
25	12.5	472156	245489	717645

Table 2.2: With Case 2 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 2: $x_{EMP} \sim N(-250\ r_{EMP} + 10000 , 2000^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	12.9	441050	248878	689928
13	12.9	445149	248878	694027
14	12.8	448782	248010	696792
15	12.7	451907	247156	699063
16	12.6	454534	246315	700849
17	12.6	456654	246315	702969
18	12.5	458272	245489	703761
19	12.4	459391	244676	704067
20	12.3	460015	243876	703891
21	12.2	460137	243088	703225
22	12.0	459749	241549	701298
23	12.0	458861	241549	700410
24	11.9	457518	240796	698314
25	11.8	455719	240054	695773

Table 2.3: With Case 3 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 3: $x_{EMP} \sim N(-200 r_{EMP} + 8000, 1600^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	12.1	428293	242313	670606
13	12.0	431463	241549	673012
14	11.9	434228	240796	675024
15	11.9	436582	240796	677378
16	11.8	438530	240054	678584
17	11.7	440066	239324	679390
18	11.6	441199	238605	679804
19	11.6	441934	238605	680539
20	11.5	442279	237896	680175
21	11.5	442236	237896	680132
22	11.4	441797	237196	678993
23	11.4	440973	237196	678169
24	11.4	439786	237196	676982
25	11.3	438252	236507	674759

Table 2.4: With Case 4 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 4: $x_{EMP} \sim N(-150 r_{EMP} + 6000, 1200^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	11.2	413387	235827	649214
13	11.2	415662	235827	651489
14	11.2	417632	235827	653459
15	11.2	419306	235827	655133
16	11.2	420684	235827	656511
17	11.1	421744	235155	656899
18	11.1	422543	235155	657698
19	11.0	423015	234493	657508
20	11.0	423196	234493	657689
21	11.0	423084	234493	657577
22	11.0	422681	234493	657174
23	11.0	421990	234493	656483
24	11.0	421033	234493	655526
25	11.0	419812	234493	654305

Table 2.5: With Case 5 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 5: $x_{EMP} \sim N(-100r_{EMP} + 4000, 800^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	11.0	396899	234493	631392
13	11.0	398391	234493	632884
14	11.0	399683	234493	634176
15	11.0	400776	234493	635269
16	11.0	401671	234493	636164
17	11.0	402367	234493	636860
18	11.0	402864	234493	637357
19	11.0	403167	234493	637660
20	11.0	403279	234493	637772
21	11.0	403187	234493	637680
22	11.0	402915	234493	637408
23	11.0	402465	234493	636958
24	11.0	401826	234493	636319
25	11.0	401012	234493	635505

Table 2.6: With Case 6 distribution, the b^*_{EMP+} and the average profits for given r_{EMP} .

Case 6: $x_{EMP} \sim N(-50r_{EMP} + 2000, 400^2)$				
r_{EMP}	b^*_{EMP+}	PAP	RAP	SAP
12	11.0	380156	234493	614649
13	11.0	380902	234493	615395
14	11.0	381549	234493	616042
15	11.0	382095	234493	616588
16	11.0	382542	234493	617035
17	11.0	382890	234493	617383
18	11.0	383139	234493	617632
19	11.0	383290	234493	617783
20	11.0	383346	234493	617839
21	11.0	383306	234493	617799
22	11.0	383170	234493	617663
23	11.0	382939	234493	617432
24	11.0	382620	234493	617113
25	11.0	382213	234493	616706

Findings 2: (From Tables 2.1 to 2.6)

1. From Tables 2.1 to 2.6, we find that the optimal buy-back prices depend heavily on the demand size of the EMP. In Cases 1 to 3, we have relatively large EMP demand and the optimal buy-back price with EMP is larger than the optimal buy-back price without EMP, i.e. $b^*_{EMP+} > b^*_{EMP-}$. In Case 4, when the EMP demand is in a moderate size, the optimal buy-back prices under the cases with and without EMP are very close to one another: $b^*_{EMP+} \approx b^*_{EMP-}$. When the EMP demand takes a relatively small value which occurs in Cases 5 and 6, the optimal buy-back price with EMP equals the optimal buy-back price without EMP, $b^*_{EMP+} = b^*_{EMP-}$. Thus, we know that with the introduction of the e-marketplace, the optimal buy-back price is always larger than or at least equal to the optimal buy-back price without the e-marketplace. Moreover, the lower the EMP demand, the smaller the difference between the optimal buy-back prices with and without EMP. It can be explained by the fact that the smaller the EMP demand, the less amount of products required to satisfy it and hence the smaller incentive of the publisher to increase the buy-back price to attract the retailers to order more (and probably return more). With the same argument, on the other hand, the larger the demand in the EMP, the larger the optimal buy-back price and a higher buy-back price can help the publisher in two ways: i. The publisher can entice the retailers to order more during the normal selling season. ii. With a larger buy-back price, the expected amount of returned products should increase. Since the EMP demand is large, the increased amount of returned products can be used to fulfill the potential demand in the EMP.
2. On the other hand, observe that the findings in *Findings 1* still hold in the cases with EMP as reflected in Tables 2.1 to 2.6.

With Tables 2.1 to 2.6, we can search for the optimal values of r^*_{EMP} *and* b^*_{EMP+} . Table 3 summarizes the optimal buy-back price and EMP selling price pair for each demand case. Compared with the case without using the EMP, the percentage changes of the average profits when the publisher adopts the EMP are shown in Table 4.

Table 3: The optimal pair: r^*_{EMP} and b^*_{EMP+} and the average profits under Cases 1 to 6.

Case	r^*_{EMP}	b^*_{EMP}	PAP	RAP	SAP
1	21.0	12.9	476621	248878	725499
2	20.7	12.2	460157	243088	703245
3	20.4	11.5	442309	237896	680205
4	20.2	11.0	423198	234493	657691
5	20.0	11.0	403279	234493	637772
6	20.0	11.0	383466	234493	617959

Table 4: The changes and the % changes of the average profits with the use of EMP under Cases 1 to 6.

	Publisher's		Retailers'		Supply Chain's	
Case	CAP	%CAP	CAP	%CAP	CAP	%CAP
1	113174	31.14%	14385	6.13%	127559	21.33%
2	96710	26.61%	8595	3.67%	105305	17.61%
3	78862	21.70%	3403	1.45%	82265	13.76%
4	59751	16.44%	0	0.00%	59751	9.99%
5	39832	10.96%	0	0.00%	39832	6.66%
6	20019	5.51%	0	0.00%	20019	3.35%

Findings 3: (Tables 3 and 4)

From Tables 3 and 4, we can observe that the average profits of the publisher, retailers in total and the overall supply chain all get improved or at least not worse than before after using the EMP. When the EMP demand is relatively large (in Cases 1 to 3), the average profits for the publisher, retailers and the supply chain all get improved. This is due to the increase of the optimal buy-back price. When the EMP demand is relatively small (in Cases 4 to 5), there is no improvement in terms of the average profit for the retailers and the amount of improvement for the publisher and also the overall supply chain will be relatively small. Thus, for the retailers, they can actually be benefited if the EMP demand is large. In fact, we find that the larger the EMP demand, the larger the improvement of the average profits for all parties. Moreover, when the fixed operations cost of the EMP is less than the publisher's improvement of average profit, the publisher should be willing to proceed. Notice that when the demand follows the distribution in Case 6, the amount of improvement for the publisher is only 20019, which is pretty small. Thus, the expected improvement of profit with the EMP is not necessarily attractive and it depends highly on the demand in the EMP. Since the demand on Internet is highly volatile, the risk of operating the EMP is high. As a result, unless the publisher is rather certain about the existence of a sufficiently large demand from the EMP, proceeding with the EMP may not be a smart decision. It also explains the situation that EMP for the publishing industry is not that popular in many places (e.g. in Hong Kong) because the EMP demand is still relatively small and uncertain.

Next, we carry out numerical analysis towards several parameters of the EMP. Notice that according to (20), the EMP demand (x_{EMP}) distributes as a normal distribution with mean of $-K_1 r_{EMP} + K_2$ and variance of s^2_{EMP}. We would like to look into the impact of the variation of each of the parameters for the distribution of x_{EMP}. Moreover, we would also check about the impact of the holding cost for the EMP. As a control setting, we will set our default EMP demand to be the one used in Case 3 above, i.e. $x_{EMP} \sim N(-200 r_{EMP} + 8000, 1600^2)$. Then we will change each of the parameters for this EMP demand and investigate its impact. The numerical results for the analysis are as shown in Tables 5 to 8 below.

Table 5: Effect of the changes in K_1 to r^*_{EMP} and b^*_{EMP} and the corresponding average profits' changes with EMP.

K_1	r^*_{EMP}	b^*_{EMP}	Publisher's	Total Retailers'	Supply Chain's
			% CAP	% CAP	% CAP
50	25	13.0	44.70%	6.51%	29.73%
100	25	12.3	36.88%	4.00%	23.99%
200	20.4	11.5	21.70%	1.45%	13.76%
300	13.6	11.3	14.45%	0.86%	9.12%

Table 6: Effect of the changes in K_2 to r^*_{EMP} and b^*_{EMP} and the corresponding average profits' changes with EMP.

K_2	r^*_{EMP}	b^*_{EMP}	Publisher's	Total Retailers'	Supply Chain's
			% CAP	% CAP	% CAP
6K	15.4	11.2	12.35%	0.57%	7.73%
8K	20.4	11.5	21.70%	1.45%	13.76%
10K	25	12.1	33.66%	3.33%	21.77%
12K	25	13.1	46.24%	6.89%	30.81%

Table 7: Effect of the changes in s_{EMP} to r^*_{EMP} and b^*_{EMP} and the corresponding average profits' changes with EMP.

s_{EMP}	r^*_{EMP}	b^*_{EMP}	Publisher's	Total Retailers'	Supply Chain's
			% CAP	% CAP	% CAP
400	19.9	11.0	21.97%	0.00%	13.36%
800	20.0	11.0	21.95%	0.00%	13.34%
1.6K	20.4	11.5	21.70%	1.45%	13.76%
3.2K	22.5	12.4	21.53%	4.34%	14.79%

Table 8: Effect of the changes in h_{EMP} to r^*_{EMP} and b^*_{EMP} and the corresponding average profits' changes with EMP.

h_{EMP}	r^*_{EMP}	b^*_{EMP}	Publisher's	Total Retailers'	Supply Chain's
			% CAP	% CAP	% CAP
2m	20.4	11.5	21.70%	1.45%	13.76%
5m	20.4	11.5	21.70%	1.45%	13.76%
0.01	20.4	11.5	21.69%	1.45%	13.76%
0.1	20.3	11.5	21.62%	1.45%	13.71%
1	20.1	11.1	20.90%	0.28%	12.81%

Findings 4: (Tables 5 to 8)

1. *When K_1 increases, both r^*_{EMP} and b^*_{EMP} decrease. The average profits for all parties also decrease:* The decrease of average profits is a very intuitive result because the larger the value of K_1, the smaller the mean of the EMP demand and it implies a smaller profit from the EMP for the publisher. Moreover, since the expected EMP demand is reduced, the

publisher need not increase the optimal buy-back price and it accounts for a loss for the retailers. Moreover, when K_1 increases, the effect of price change will become more prominent and it explains why the optimal EMP selling price decreases upon the increase of K_1.

2. *When K_2 increases, both r^*_{EMP} and b^*_{EMP} increase. The average profits for all parties also increase:* K_2 is the constant term for the mean of the EMP demand. An increased K_2 implies a larger expected EMP demand and it makes the optimal buy-back price b^*_{EMP} and all the average profits increase. On the other hand, similar to the comment we have made in Point 1 above, when K_2 increases, the relative significance of K_1 decreases and the EMP demand is less sensitive to the price changes. An increased r^*_{EMP} hence results.

3. *When s^2_{EMP} increases, both r^*_{EMP} and b^*_{EMP} increase. The publisher's average profit is reduced while the retailers' average profit increases:* Since the supply chain's average profit is affected by the average profits of the retailers and the publisher, the effect of increasing s^2_{EMP} may increase or decrease the supply chain's average profit. This is an interesting finding. First of all, an increased s^2_{EMP} implies an increased EMP demand uncertainty. When the uncertainty increases, in order to maximize the profit for the EMP, the publisher tends to hold more returned products (P.S: The concept of safety stock inventory). As a result, the optimal buy-back increases. An increased demand uncertainty also implies a drop in the significance of the mean of the demand. This gives a larger r^*_{EMP}.

4. *When h_{EMP} varies, the effect to the optimal solution pair of r^*_{EMP} and b^*_{EMP} is very small.* The impact for the average profits for all parties is small too. Thus, when the EMP holding cost h_{EMP} is within reasonable range, its effect is to all the parties is small.

Other Discussions:

In the system point of view, the introduction of the EMP in this example is beneficial (or at least not harmful) to the publisher, the retailers and also the whole supply chain when the profit generated is larger than the expense of operating the EMP for the publisher **. In fact, the use of EMP in the setting proposed in this paper can be beneficial and is never harmful to the retailers. Owing to the potential demand from the EMP, the publisher will increase the buy-back price offered to the retailers, when every other cost parameter remains constant. It is obvious that the higher the buy-back price, the higher the expected profit for the retailers. As a result, if the use of EMP is beneficial to the publisher (e.g. the net expected profit improvement overrides the fixed operations cost) and the publisher goes ahead with it, the retailers can also be benefited. This creates a win-win situation and the overall supply chain's expected profit is also improved.

**Remarks: We have assumed in this paper that the existence of EMP does not affect the market demand during the normal selling season for the retailers. Although we have explained about this point earlier in this paper, if the existence of EMP does affect the demands faced by the retailers, then the existence of EMP will give both a positive impact (potential increase of buy-back price from the publisher) and negative impact (lower demand) to the retailers. As a result, whether the retailers will get better off or not depends on the relative significance between these two issues.

CONCLUSION

In this paper, we have proposed a quantitative supply chain management model for using the e-marketplace to sell returned products in the publishing industry. We illustrate the application of the buy-back return policy and through the simulation studies towards a local publisher's case, we discuss the managerial and strategic issues of using the e-marketplace. In our model, we find that the introduction of the e-marketplace can be beneficial to the retailers and whether the publisher and the overall supply chain is benefited depends on his fixed operations cost and the demand in the e-marketplace. For the e-marketplace with moderate and large demand, we find that the improvement of expected profits for the publisher, the retailers and also the supply chain can be substantial. Owing to the fact that Internet targets at a global market without geographical barrier, the potential demand for those "locally fade-out" products can be high.

As a result, the importance of using Internet as an e-marketplace for returned products should not be neglected and it can yield significant improvement on the profit for the existing supply chains.

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