

ELECTRONIC MARKETPLACE FOR RETURNED PRODUCTS IN THE PUBLISHING INDUSTRY

A Simulation Analysis

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In the publishing industry, the publishers supply products like the magazines, novels and books to the retailers. In order to encourage the retailers to order more, the publishers usually adopt a buyback policy under which the retailers can return the unsold products to the publishers for a partial refund. In the past, owing to a lack of retail sales channel, most of the returned products were salvaged at a very low price. Now, with the advance of e-commerce, the publishers can make use of the Internet as an electronic marketplace (EMP) to sell those returned products to a completely different market segment - the World-Wide-Web. Since the Internet offers a global open system, it breaks the geographical barrier and the demand for those "locally faded-out" goods can be substantial. In light of this, we study in this paper a supply chain with one publisher and multiple retailers. Through extensive simulation studies, we study the managerial and strategic issues with the use of the EMP as a secondary market for the locally faded-out products.

KEYWORDS: Electronic marketplace, supply chain buyback policy, simulations, correlated demands, mean-variance analysis, risk management.

INTRODUCTION

We are now in the information age. With a continuous decrease in prices of computer and Internet access service, going online is not a luxurious activity anymore. With the popular-

ity of the Internet and the growing confidence about the reliability and security of the network, e-commerce has a bright future. It is predicted that the dollar amount of the B2C and B2B e-commerce transactions will continue to grow in the foreseeable future (for a proof of

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these claims, see Ward, 2000). For the direct sales type of B2C business, it is also believed that the Internet would provide a frictionless, open, free and perfectly competitive market for B2C transactions. Some research has been done in challenging that claim by empirical studies (e.g. Brynjolfsson and Smith, 2000). Despite the many attracting features associated with the B2C direct sales channel (see Turban et al., 2000), B2C is currently much less significant compared to B2B in the e-commerce world. While the specific forecast results vary, Enos (2000) has predicted that B2B will represent 87 percent of all e-commerce transactions and it would account for nearly \$2.8 trillion by 2004 (for some other forecast figures, see Lucking-Reiley and Spulber, 2001; Chen and Siems, 2001). In fact, the optimistic forecast for the future of B2B is justified by several significant features of B2B systems. In Lucking-Reiley and Spulber (2001), many important features of B2B are discussed: The reduction of traditional business costs (like the procurement cost, searching cost and advertisement cost, etc), the productivity gains from the automation of transactions, and the improvement of the economic efficiency brought by the intermediation effect. It is also proposed that the ultimate greatest beneficiaries of B2B will be the consumers (Siems, 2001) because the consumers would enjoy lower prices than before with B2B.

In order to perform B2B transactions, companies need to have a good network and linkage with the customers (i.e. the other businesses) and other business partners. The companies can definitely establish their own websites and conduct B2B over there. However, a more effective way is to use the service provided by the e-hub (also called the electronic marketplace). The e-hub is an Internet business model where it provides a virtual marketplace to link the buyers and sellers together. Some well-known companies acting as the e-hubs include Asia Capacity Exchange, Covisint, e-jing technologies, etc.

The use of the electronic marketplace for selling excess inventory has been described in

Keskinocak and Tayur (2001) and its use as a distribution channel in agribusiness industries has been investigated by Henderson et al. (2001). The impacts of electronic markets on B2B supply chain relationships have been studied by Haller (2002) and some other related articles can be found from the literature review in Yau (2002). Since the Internet features a global market, companies can make use of it to sell some of the excess productions, unsold items or even second hand products to places all around the globe. With B2B, some redudant or faded-out products in one place may be of the interests of customers in other places. This feature brings the incentive for us to study in this paper an optimal buyback policy with the use of the electronic marketplace in the publishing industry. We consider a simple two-echelon supply chain with a single publisher who supplies a single item to multiple retailers. It is a usual practice in the publishing industry that the publisher will adopt a buyback policy. Under this buyback contract, 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. (Notice that this type of policy with different extensions has been widely studied in the literature and the first well-recognized quantitative analysis of the buyback policy is Pasternack (1985)). Under the original practice, the publisher uses a buyback contract 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, should the publisher consider selling those returned products in the electronic marketplace with a higher price? If yes, would the originally optimal buyback price increase? What would be the impact of this action on the profit of the publisher, the retailers and the overall supply chain? Is there any drawback? What are the measures to be evaluated before taking the action? Through extensive simulation analysis, we attempt to answer all these questions. In short, we would like to study the impacts associated with the use of the

electronic marketplace for selling the returned products in the publishing industry and develop some managerial insights for this topic. Moreover, we know that the buyback policy has been applied in the publishing industry for a long time but the use of the electronic marketplace as a secondary market for doing B2B and B2C for the locally faded-out products is not popular at all. Is it a slow evolution or are there some other reasons for it? We would also explain this phenomenon in this paper based on some observations in the simulation studies. Moreover, we would look into the situations where the electronic marketplace and the local market segments are correlated in different ways.

The organization of the rest of this paper is as follows: We first propose the basic model and define the parameters. Afterwards, we talk about the methodology and some technical details of the simulation studies. A specific case is chosen and described as the simulation target. The simulation results and findings are then reported. Finally, we discuss the managerial insights and conclude with a suggestion for future research.

MODEL

In this paper, we study a two-echelon supply chain in the publishing industry. We consider a publisher who supplies a single product to multiple retailers. This product can be a magazine, a novel or a book, etc. The normal selling season of this product is short. For example, for a 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 magazine to the publisher following a buyback policy. For example, suppose a publisher offers to the retailers a unit wholesale price of \$100 and a unit buyback price of \$20. Then after the selling season, the retailers can return any unsold product to the publisher to get a \$20 refund for each returned product. Owing to the legal issue of fairness, the unit buyback price offered by the publisher must be

the same for all retailers. In the old practice without the electronic marketplace, the publisher would salvage the returned products at a low unit salvage price. Now, with the Internet, the publisher can consider selling the returned products with a higher price (higher than the salvage price) through the Internet. This is an example of using the Internet to sell excess products as mentioned in Keskinocak and Tayur (2001).

In this paper, we would carry out a computer simulation analysis with the use of the electronic marketplace for selling those returned products. First, we need to define some cost-revenue parameters. We consider in this paper that the product has a fixed market retail selling price r for all retailers during the normal selling season. For the retailers, the unit ordering cost c for the product is fixed. Following the buyback policy, at the end of the selling season, the unsold product can be returned to the publisher at a unit buyback price b . The unsold product also costs the retailer a unit holding expense h . For the publisher, the unit production cost is m . After the retailers have returned the unsold products, the publisher can sell them to the salvage market with a unit salvage value v . Besides salvaging the returned products at a low salvage value v , the publisher can also consider selling these products in the electronic marketplace with a unit selling price of r_{EMP} . If the publisher chooses to sell the returned products through the electronic marketplace and some products cannot be sold finally, it will incur an additional unit holding cost h_{EMP} but it can still be sold to the salvage market. Moreover, in order to use or establish the electronic marketplace, the publisher needs to pay a fixed service/operational cost C_{EMP} . In order to avoid trivial cases, we have $v \leq b \leq c$ and $v \leq r_{EMP}$. Moreover, we consider the situation under which the fixed setup cost of producing the products is high. This matches with the industrial practice in the publishing industry. In this paper, there are multiple retailers and a single publisher (the sole supplier of the product). The market demand for the product faced by each retailer

is uncertain and follows a certain distribution (denoted with probability distribution function of $g_i(\cdot)$, cumulative distribution function of $G_i(\cdot)$ for retailer i). This retail market demand includes all the demands faced by the specific retailers under all possible sales channels: e.g. it can include both the conventional brick and mortar stores-sales and the online direct-sales.

After the normal retail selling season, if the publisher uses the electronic marketplace to sell the returned products, the corresponding e-market demand is represented by x_{EMP} .

Since x_{EMP} obviously depends on the selling price of the product in the electronic marketplace (r_{EMP}), we treat it as a price dependent variable with the following structure:

$$x_{EMP} = -K_1 r_{EMP} + K_2 + \epsilon_{EMP}, \quad (1)$$

where K_1, K_2 are positive constants and ϵ_{EMP} is a continuous random variable with a well-defined probability density function of $g_{EMP}(\cdot)$. Notice that the above demand distribution follows the well-known linear price dependent demand distribution model in the literature (see Lau and Lau, 1988).

With all these details, Figure 1 shows the basic model of the problem. Notice that in Figure 1 and in this paper, *EMP* stands for “*electronic marketplace*.” The sequence of the events in Figure 1 is 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 EMP. After the end of the sales via the EMP, any unsold products are salvaged.

As a remark, we do not consider the situation where the publisher sells directly via the EMP at the first time instance because of the potential occurrence of the channel conflicts between the publisher and the retailers if the publisher sells online at the very beginning. A real-world example can be found from the website of a book distributor—Koen.com. On Koen.com’s website, there is a statement saying that Koen.com only sells the books to the bookstores and the resale customers. Koen.com will not sell the books to the other individuals and Koen.com even recommends the other customers to buy from the linked bookstores. This action will prevent the occurrence of the channel conflicts. Moreover, our

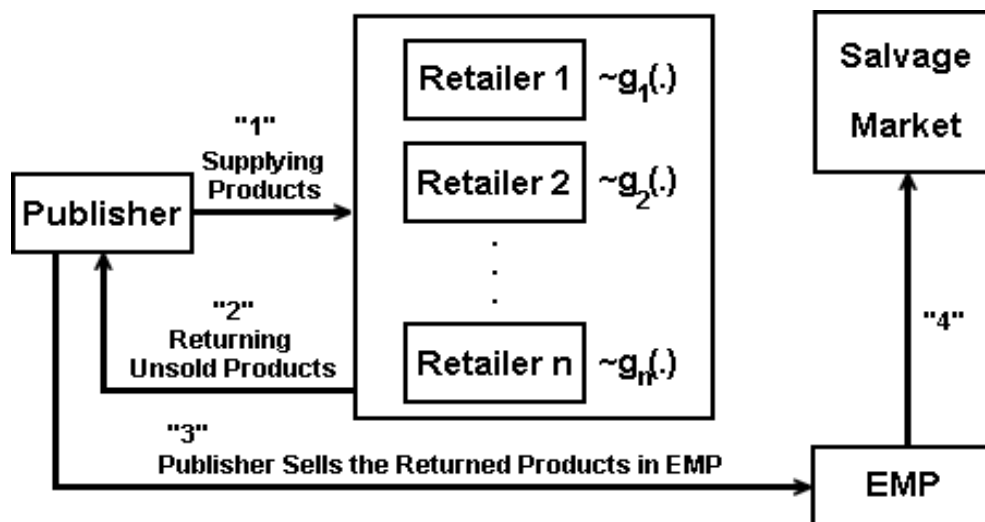


FIGURE 1
The Basic Supply Chain Model with the Electronic Marketplace (EMP).

focus in this paper is on the use of the EMP as a global virtual market for selling excessive products. The direct sales channel is outside our scope. Further notice that the supply chain discussed in this paper can be generalized for other industries as well. For example, the publisher (in Figure 1) can be replaced by a manufacturer of an electronic device (e.g. a digital camera) and the use of the EMP for selling the locally faded-out product is still valid.

METHODOLOGY—SIMULATION STUDIES

In this paper, we would like to study through simulation analysis the impacts, benefits and potential drawbacks associated with the use of the EMP for selling the returned products. To make the simulation more realistic, we obtain some data of a local publisher and estimate the demand and cost-revenue structures faced by this publisher. With these details, we implement a computer simulator for this publisher-retailers supply chain. To be specific, we have the following details.

Case Description

A Hong Kong publisher publishes a funny book series with the main theme of making joke towards some well-known people in Hong Kong. The publisher publishes about 6 funny books a year and she supplies the books to hundreds of major retailers in Hong Kong. The sales of the three most recent publications are reported to be 40000, 20000 and 35000 copies, respectively. The recommended unit retail selling price of the funny book is \$25 and it is known that the publisher can earn approximately half of all the revenue. This publisher has used the buyback policy as a practice to entice retailers to order more. According to the publisher's previous experience, the normal selling season of each edition of the funny book series is about 1 to 2 months. After that, the retailers will return the books to the publisher for a partial refund. Since the retail mar-

ket is highly volatile and the overall demand is substantial, the amount of returned books is not trivial. From the empirical details and some of the data reported in an interview of the publisher by a local magazine (Wong, 2001), we have estimated the following cost-revenue parameters:

- The unit production cost of the funny book $m = \$4$.
- The unit wholesale price of the funny book $c = \$16$.
- The recommended unit retail selling price of the funny book $r = \$25$.
- The monthly unit holding cost of the funny book $h = \$0.0267$.
- The unit value of the funny book in the salvage market $v = \$0.01$.

We assume in the following that the publisher supplies the funny book to about 400 major retailers in Hong Kong (and they may split the orders to other smaller newsvendors, etc). We would carry out simulation experiments in two directions. The first one assumes that the demands of the local retail market and the EMP are independent. In the second model, we study the situations where the local retail market's aggregate demand is correlated to the EMP's demand.

Model 1: Independent Demands Between the Local Retail Market and the EMP

In Model 1, we classify the 400 retailers into three groups according to different demand levels: The high demand, medium demand and low demand groups, respectively. To be specific, the demand distributions for high, medium and low demand groups are as shown below (all are normal distributions where the first and second arguments in $N(\cdot)$ represent the mean and variance of the distribution, respectively):

$$x_{High} \sim N(210, 70^2), x_{Medium} \sim N(60, 20^2), \\ x_{Low} \sim N(15, 5^2).$$

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

Next, we consider the case with the EMP. Following the previous discussion, suppose that the demand in the EMP follows the price-dependent demand structure defined in Equation (1) for all $1 \leq r_{EMP} \leq 25$:

$$x_{EMP} \sim N(-K_1 r_{EMP} + K_2, \sigma_{EMP}^2).$$

In order to study the effect of high and low demands in the EMP, we would carry out simulation experiments with different values of these parameters as shown in Table 1. Notice that the values of K_1 and K_2 are set in a way that $-K_1 r_{EMP} + K_2$ is always positive with any $1 \leq r_{EMP} \leq 25$. Moreover, careful observation reveals that $K_2/K_1 = 40$ and the ratio of $K_2/\sigma_{EMP} = 5$. By doing so, the coefficient of variation of all the demand distributions for any given r_{EMP} becomes $8/(40 - r_{EMP})$. The impact brought by changing r_{EMP} on the degree of uncertainty of the demand distribution is hence the same.

Model 2: Correlated Demands Between the Local Retail Market and the EMP

In Model 2, we want to investigate the impact and the profit uncertainty issues associ-

ated with the use of the EMP under different correlations between the local retail market and the EMP. Thus, instead of considering the situation with 400 individual retailers, we group them into an aggregate local market retailers' set and the demand is given as follows:

$$x_{Aggregate} \sim N(32400, 10800^2). \quad (2)$$

Notice that the mean of $x_{Aggregate}$ is equal to the summation of the means of all 400 retailers in Model 1. Moreover, the coefficient of $x_{Aggregate}$ variation for is 1/3 which is also the same the coefficient of variation for each retailer in Model 1. In Model 2, the demand in the EMP also takes the price dependent structure as used in Model 1:

$$x_{EMP} \sim N(-K_1 r_{EMP} + K_2, \sigma_{EMP}^2)$$

To be specific, we have the following distribution for the EMP under Model 2:

$$x_{EMP} \sim N(-135 r_{EMP} + 5400, 1080^2) \quad (3)$$

Observe that depending on different values of r_{EMP} , the mean of x_{EMP} defined in Equation (3) varies.

In Model 2, since we would like to study the impact of the correlation of the demands between the local retail market and the EMP, we define the following covariance matrices for the cases with different degrees of positive correlation and negative correlation, respectively (“2” is more correlated than “1”):

TABLE 1
Different Parameter Values for Simulation Analysis

Case	K_1	K_2	σ_{EMP}
1	300	12000	2400
2	250	10000	2000
3	200	8000	1600
4	150	6000	1200
5	100	4000	800
6	50	2000	400

- Positive correlation:

$$- (M1+): \begin{pmatrix} 10800^2 & 2600^2 \\ 2600^2 & 1080^2 \end{pmatrix}$$

$$- (M2+): \begin{pmatrix} 10800^2 & 3200^2 \\ 3200^2 & 1080^2 \end{pmatrix}$$

- Negative correlation:

$$- (M1-): \begin{pmatrix} 10800^2 & -2600^2 \\ -2600^2 & 1080^2 \end{pmatrix}$$

$$- (M2-): \begin{pmatrix} 10800^2 & -3200^2 \\ -3200^2 & 1080^2 \end{pmatrix}$$

Among the above covariance matrices, (M2+) shows a larger positive correlation between the two demands than (M1+). Similarly, (M2-) shows a larger negative correlation than (M1-). With the above correlation matrices, using the method proposed in Law and Kelton (1991), we can generate the multivariate normally distributed random variables as the demands in the local retail market and the EMP, respectively. We can then study the impact of different correlations among them.

Technical Details and Notations

With all the modelling details above, we can start our simulation studies. During the simulation, demands for the retailers following the respective distributions are randomly generated by the computer programs (reference: Gottfried, 1990; Law and Kelton, 1991) and the corresponding average profits are found. Notice that for a given buyback price b , the corresponding optimal order quantity placed by each retailer is known following the classic results in the newsboy problem (see Technical Appendix A1). For the case with the EMP, after the total amount of returned product is

known, the optimal EMP selling price can be computed dynamically by a numerical line search (please refer to Technical Appendix A2).

In this paper, all simulation results are obtained after running simulation experiments for 500 times. For the case with the EMP, the optimal buyback price and the optimal EMP selling price are found with an accuracy of 1 decimal place. Moreover, to be more precise, we also include the 90 percent confidence interval, represented by 90%CI, for measuring the uncertainty bound for the simulation generated average profits:

The 90 percent confidence interval

$$(90\%CI) = AP \pm 1.645 \times \sqrt{VP/n},$$

where AP denotes the average profit, VP denotes the variance of profit and n is the number of simulation experiments conducted.

We define the 90 percent confidence interval bounds, CIB, as follows:

$$(CIB) = AP \pm 1.645 \times \sqrt{VP/n}.$$

Obviously, CIB measures how accurate the simulation generated average profit is.

For a notational purpose, we have the following:

- AP = Average profit,
- SD = Standard deviation of profit,
- ΔAP = Change of average profit,
- ΔSD = Change of standard deviation of profit,
- $\% \Delta AP$ = Percentage change of average profit,
- $\% \Delta SD$ = Percentage change of standard deviation of profit,
- b_{EMP*} = The optimal unit buyback price with the use of the EMP,
- b_* = The optimal unit buyback price without the use of the EMP.

SIMULATION RESULTS AND FINDINGS

We state in this section the simulation results for the two models proposed in the previous section. We also discuss the findings from these results.

Model 1—Independent Demands

Under Model 1, we list in Table 2 the average profits for the publisher, the retailers-in-total and the supply chain with different values of buyback price b under the case without the EMP in Model 1. Notice that the average profit of the supply chain is equal to the summation of the publisher's and retailers-in-total's average profits. Moreover, searching for the optimal buyback 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. On

the other hand, if we search for the optimal buyback 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.

Findings 1: (From Table 2)

1. From Table 2, we can observe that when the buyback price b increases, the retailers-in-total's average profit increases. It is very intuitive because a higher buyback price implies that the retailers can return the unsold products with a higher return price. It directly accounts for the increase of the retailers-in-total's average profit.
2. In the case without the EMP, the publisher's optimal buyback price (11.0) is not equal to the supply chain's optimal buyback price (which we have found to be 14.3). It means that the supply chain

TABLE 2
Average Profits of All Parties with Different b when there is No EMP

b	<i>Publisher's</i>		<i>Retails-In-Total's</i>		<i>Supply Chain's</i>	
	<i>AP</i>	<i>CIB</i>	<i>AP</i>	<i>CIB</i>	<i>AP</i>	<i>CIB</i>
0.01	342261	0.0	189921	556.1	532182	556.1
1	344564	22.6	192609	548.4	537173	571.0
2	346909	46.7	195492	540.6	542401	587.3
3	349262	72.2	198563	532.5	547825	604.7
4	351606	99.5	201851	524.6	553457	624.1
5	353916	128.7	205383	516.8	559298	645.5
6	356154	160.4	209187	509.5	565342	669.9
7	358274	194.5	213315	501.7	571589	696.2
8	360203	231.7	217826	493.6	578029	725.2
9	361835	272.4	222793	485.7	584628	758.1
10	363004	317.1	228306	477.1	591311	794.2
11	363447	366.6	234493	467.8	597940	834.4
12	362734	422.4	241549	459.0	604283	881.4
13	360084	487.6	249761	451.4	609844	939.0
14	353864	563.7	259605	444.3	613469	1008.0
15	339642	655.5	272047	438.5	611689	1093.9
15.9	295209	764.1	287934	438.9	583144	1203.0

TABLE 3
The Average Profits of All Parties with the EMP under Cases 1 to 6

Case	b_{EMP}^*	Publisher's		Retailers-In-Total's		Supply Chain's	
		AP	CIB	AP	CIB	AP	CIB
1	12.9	476643	3351.0	248878	452.1	725520	3436.9
2	12.2	460166	2856.1	243088	457.2	703254	2954.9
3	11.5	442316	2352.1	237896	463.5	680211	2470.2
4	11.0	423196	1833.8	234493	467.8	657688	1984.0
5	11.0	403279	1255.0	234493	467.8	637771	1464.8
6	11.0	383346	704.5	234493	467.8	617839	1030.7

is not optimal with respect to the expected profit measure and a double marginalisation occurs. This is due to the fact that there is no coordination in this supply chain system.

Next, we consider the case with the EMP. Table 3 shows the optimal buyback price and the corresponding average profits for the publisher, the retailers-in-total and the supply chain under different cases (P.S.: These cases have been defined in Table 1 in the previous section). Notice that we have not included the fixed operations cost of the EMP in the simulation results. Moreover, during the simulation experiments, the optimal EMP selling price is set dynamically with respect to the total amount of returned products as described in Technical Appendix A2.

As we have found before, when there is no EMP, the optimal buyback price b_* is found to be 11.0 and the corresponding APs for the pub-

lisher, the retailers-in-total and the supply chain are 363447, 234493, and 597940, respectively. Now, comparing to this case (the case without the use of the EMP), when the publisher uses the EMP for selling the returned products, the changes and percentage changes of the average profits are summarized in Table 4.

Findings 2: (From Tables 3 and 4)

1. From Table 3, we find that the optimal buyback prices depend heavily on the demand size of the EMP. In Cases 1 to 3, we have relatively large EMP demands and the optimal buyback prices with EMP are larger than the optimal buyback price without the EMP. When the EMP demands are relatively small (e.g. in Cases 4, 5 and 6), the optimal buyback prices with the EMP equal the optimal buyback price

TABLE 4
 ΔAP and $\% \Delta AP$ with the EMP under Cases 1 to 6

Case	Publisher's		Retailers-In-Total's		Supply Chain's	
	ΔAP	$\% \Delta AP$	ΔAP	$\% \Delta AP$	ΔAP	$\% \Delta AP$
1	113196	31.1%	14385	6.1%	127580	21.3%
2	96719	26.6%	8595	3.7%	105314	17.6%
3	78869	21.7%	3403	1.5%	82271	13.8%
4	59749	16.4%	0	0.0%	59748	10.0%
5	39832	11.0%	0	0.0%	39831	6.7%
6	19899	5.5%	0	0.0%	19899	3.3%

without the EMP. Thus, we know that with the introduction of the EMP, the optimal buyback price is always larger than or at least equal to the optimal buyback price without the EMP. Moreover, the larger the expected demand in the EMP, the larger the optimal buyback price and a higher buyback 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 buyback price, the expected amount of returned products should increase. Since the EMP demand is large, the increased expected amount of returned products can be used to fulfill the potential demand in the EMP.

2. From Table 4, we can observe that the average profits of the publisher, the 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, the retailers-in-total and the supply chain all get improved. The improvement is especially substantial to the publisher and the supply chain. Notice that for Cases 4 to 6, there is no improvement in terms of the average profit for the retailers because the buyback price remains unchanged after using the EMP in these cases.
3. If we only consider the average profit measure, when the fixed operations cost of the EMP is less than the publisher's improvement of average profit,

the publisher should proceed with the EMP. Notice that when the demand follows the distribution in Case 6, the amount of average profit improvement for the publisher is only 19899 (~5.5%), which is pretty small. It tells us that the improvement of profit with the EMP is not necessarily attractive and it depends highly on the size of the demand in the EMP. Thus, in the countries where e-commerce is not popular and the expected e-market size is small, the effectiveness of using the EMP for selling the returned products is under doubt.

Now, we carry out numerical analysis towards several parameters of the EMP. Notice that according to Equation (1), the EMP demand (x_{EMP}) distributes as a normal distribution with a mean of $-K_1 r_{EMP} + K_2$ and a variance of σ_{EMP}^2 . We would like to look into the impact brought by varying each EMP demand distribution parameter. Moreover, we would also check the impact brought by varying the holding cost h_{EMP} . These analyses would give us a better picture about the significance of the use of the EMP under different situations. As a control setting, we set our default EMP demand to be the one used in Case 3 above, i.e.

$$x_{EMP} \sim N(-200r_{EMP} + 8000, 1600^2).$$

We then vary each of the parameters for this EMP demand and observe the average profits and the changes of average profits compared to the case without the EMP. The numerical results for these analyses are as shown in Tables 5 to 8 below.

TABLE 5
b_{EMP*}, AP and %ΔAP of All Parties with Different K₁

K ₁	b _{EMP*}	Publisher's		Retailers-In-Total's		Supply Chain's	
		AP	%ΔAP	AP	%ΔAP	AP	%ΔAP
50	13.0	525365	44.55%	249761	6.51%	775126	29.63%
100	12.3	497179	36.80%	243876	4.00%	741054	23.93%
200	11.5	442316	21.70%	237896	1.45%	680211	13.76%
300	11.3	415962	14.45%	236507	0.86%	652468	9.12%

TABLE 6
 b_{EMP^*} , AP and $\% \Delta AP$ of All Parties with Different K_2

K_1	b_{EMP^*}	Publisher's		Retailers-In-Total's		Supply Chain's	
		AP	$\% \Delta AP$	AP	$\% \Delta AP$	AP	$\% \Delta AP$
6000	11.2	408298	12.34%	235827	0.57%	644125	7.72%
8000	11.5	442316	21.70%	237896	1.45%	680211	13.76%
10000	12.1	485774	33.66%	242313	3.33%	728086	21.77%
12000	13.1	531239	46.17%	250661	6.89%	781900	30.77%

TABLE 7
 b_{EMP^*} , AP and $\% \Delta AP$ of All Parties with Different σ_{EMP}

K_1	b_{EMP^*}	Publisher's		Retailers-In-Total's		Supply Chain's	
		AP	$\% \Delta AP$	AP	$\% \Delta AP$	AP	$\% \Delta AP$
400	11.0	443310	21.97%	234493	0.00%	677802	13.36%
800	11.0	443216	21.95%	234493	0.00%	677709	13.34%
1600	11.5	442316	21.70%	237896	1.45%	680211	13.76%
3200	12.4	441136	21.38%	244676	4.34%	685812	14.70%

TABLE 8
 b_{EMP^*} , AP and $\% \Delta AP$ of All Parties with Different h_{EMP}

K_1	b_{EMP^*}	Publisher's		Retailers-In-Total's		Supply Chain's	
		AP	$\% \Delta AP$	AP	$\% \Delta AP$	AP	$\% \Delta AP$
0.002	11.5	442325	21.70%	237896	1.45%	680220	13.76%
0.005	11.5	442316	21.70%	237896	1.45%	680211	13.76%
0.010	11.5	442299	21.70%	237896	1.45%	680194	13.76%
0.100	11.4	442016	21.62%	237196	1.15%	679212	13.59%
1.000	11.1	439399	20.90%	235155	0.28%	674554	12.81%

Findings 3: (From Tables 5 to 8)

1. When K_1 increases, b_{EMP^*} decreases and the average profits of 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 average profit that can be gained from EMP for the publisher. Moreover, since the expected EMP demand is reduced, the publisher need not increase the optimal buyback price and it accounts for a loss to the retailers. Both the average profits of the publisher and the retailers-in-total get decreased upon the increase of K_1 . This also brings a decrease of the supply chain's average profit.
2. When K_2 increases, b_{EMP^*} increases and the average profits of 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 buyback price b_{EMP^*} and all the average profits increase.
3. When σ_{EMP}^2 increases, b_{EMP^*} increases and the publisher's average profit is

TABLE 9
b*, AP and SD of All Parties

<i>b*</i>	<i>Publisher's</i>			<i>Retailers-In-Total's</i>			<i>Supply Chain's</i>		
	<i>AP</i>	<i>SD</i>	<i>CIB</i>	<i>AP</i>	<i>SD</i>	<i>CIB</i>	<i>AP</i>	<i>SD</i>	<i>CIB</i>
11.0	361331	85192	6267.3	231791	108732	7999.0	593122	193924	14266.3

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 σ_{EMP}^2 may increase or decrease the supply chain's average profit. This is an interesting finding. First of all, an increased σ_{EMP}^2 implies an increased EMP demand uncertainty. When the uncertainty increases, in order to maximize the profit for the EMP, the publisher tends to welcome more returned products. As a result, the optimal buyback increases.

- When h_{EMP} varies, the value of b_{EMP*} does not change much. The impact on the average profits of all parties is small, too. Thus, when the EMP holding cost h_{EMP} is within a reasonable range (with respect to its physical meaning), its impact on all the supply chain's parties is insignificant.

To summarize, a smaller K_1 , a larger K_2 and a smaller σ_{EMP} would increase the publisher's

improvement of average profit. These factors would hence favour the use of the EMP from the publisher's perspective. On the other hand, h_{EMP} is not an important factor.

Model 2—Correlated Demands

Under Model 2, when we do not have the EMP, with the aggregate retail market's demand defined by (2), the publisher's optimal buyback price is 11.0 (the same as the one in Model 1). The corresponding average profit and standard deviation of profit of all parties are as shown in Table 9.

Now, with the EMP, Table 10 summaries the simulation results for the optimal buyback price, the average profits, and the standard deviations of profits of all parties under different correlation-situations (reference: The covariance matrices defined in the previous section). Notice that a zero correlation refers to the situation where the local retail market's demand is independent of the EMP.

In Tables 11 to 13, we show the impact brought by the EMP, compared to the case without the EMP under different correlations,

TABLE 10
 b_{EMP*} , AP and SD of All Parties under Different Correlation Situations

<i>b*</i>	<i>Publisher's</i>			<i>Retailers-In-Total's</i>			<i>Supply Chain's</i>			<i>b*</i>
	<i>AP</i>	<i>SD</i>	<i>CIB</i>	<i>AP</i>	<i>SD</i>	<i>CIB</i>	<i>AP</i>	<i>SD</i>	<i>CIB</i>	
(M2)+	13.0	389123	109902	8085.1	247918	105161	7736.3	637042	213909	15736.6
(M1)+	12.9	391892	104226	7667.6	246975	105327	7748.6	638867	208149	15312.8
Zero	12.7	396778	93391	6870.5	245152	105677	7774.3	641930	197402	14522.2
(M1)-	12.6	401451	83987	6178.6	244274	105863	7788.0	645724	188450	13863.6
(M2)-	12.6	403671	79801	5870.7	244274	105863	7788.0	647943	184738	13590.6

TABLE 11
The Publisher's ΔAP , $\% \Delta AP$, ΔSD , and $\% \Delta SD$ after Using the EMP under Different Correlations

Correlation	Publisher's			
	ΔAP	$\% \Delta AP$	ΔSD	$\% \Delta SD$
(M2)+	27792	7.69%	24710	29.01%
(M1)+	30561	8.46%	19034	22.34%
Zero	35447	9.81%	8199	9.62%
(M1)-	40120	11.10%	-1205	-1.41%
(M2)-	42340	11.72%	-5391	-6.33%

TABLE 12
The Retailers-in-total's ΔAP , $\% \Delta AP$, ΔSD , and $\% \Delta SD$ after Using the EMP under Different Correlations

Correlation	Publisher's			
	ΔAP	$\% \Delta AP$	ΔSD	$\% \Delta SD$
(M2)+	16127	6.96%	-3571	-3.28%
(M1)+	15184	6.55%	-3405	-3.13%
Zero	13361	5.76%	-3055	-2.81%
(M1)-	12483	5.39%	-2869	-2.64%
(M2)-	12483	5.39%	-2869	-2.64%

on the publisher, the retailers-in-total, and the supply chain, respectively.

Findings 4: (From Tables 10 to 13)

1. In Table 10, when we look at the standard deviations of profits of the publisher, the retailers-in-total and the supply chain, we can see that they are
2. In Table 11, we find that different correlations contribute different degrees of uncertainty to the use of the EMP for the publisher:
 - a. Positively correlated demands:
When the local retail market and the EMP are positively correlated, the

really substantial with respect to the average profit.

TABLE 13
The Supply Chain's ΔAP , $\% \Delta AP$, ΔSD , and $\% \Delta SD$ after Using the EMP under Different Correlations

Correlation	Publisher's			
	ΔAP	$\% \Delta AP$	ΔSD	$\% \Delta SD$
(M2)+	43920	7.40%	19985	10.31%
(M1)+	45745	7.71%	14225	7.34%
Zero	48808	8.23%	3478	1.79%
(M1)-	52602	8.87%	-5474	-2.82%
(M2)-	54821	9.24%	-9186	-4.74%

increase of the standard deviation of profit for the publisher after using the EMP is very large (even larger than the corresponding change of average profit). We know that when the demands are positively correlated, they will go up or go down together. For a fixed buyback policy, this would also imply a larger fluctuation in terms of the profit and this is the reason behind the proposed finding.

- b. Negatively correlated demands: When the demand in the local retail market is negatively correlated to the demand in the EMP, we find that the standard deviation of profit for the publisher after using the EMP is decreased. The fact is due to the compensating effect of the two markets. For instance, when the local retail market's demand is low, the amount of the returned products is high. Owing to the negative demand correlation, the demand in the EMP will be high and this can cope with the increased amount of the returned products.
 - c. Independent demands: The impact is in-between of the cases with positive and negative correlations.
3. For the publisher, we can observe that "the larger the degree of negative correlation between the demands of the local retail market and the EMP, the larger the amount of average profit's increase". Thus, a larger degree of negative correlation can bring a larger average profit and a smaller standard deviation of profit. It gives a dominating improvement to the publisher. For the retailer, the amount of average profit's increase gets smaller with a larger degree of negative correlation (between the demands). This is due to the reduced buyback price. For the supply chain, the impact is the mix contrib-

uted by the publisher and the retailers-in-total.

MANAGERIAL INSIGHTS

In the above simulation studies, we have generated many findings. We would explore them deeply and propose some managerial insights in this section. First, from the above analyses, we can see that the potential usefulness of the EMP should not be ignored. Using the EMP as a secondary market for the returned products can better utilize the channel flexibility while it does not create the problem of channel conflicts that may arise if the publisher sells online directly at the first time instance. With a moderately large demand size in the EMP, the profit improvement for the publisher can be substantial. When the publisher increases the buyback price upon the use of the EMP, the retailers will also be benefited and this also implies an increase of the overall supply chain's profit. This is the beauty behind the proposed model of using the EMP. However, when the EMP demand is small, the profit generated from the EMP may not be able to compensate for the operations cost. Moreover, as we all know, the demand on the Internet is highly volatile. If the expected net gain from the use of the EMP is not large enough to compensate the potential risk due to the uncertain demand, it is not a wise decision to proceed with the EMP. This fact also explains a real-life observed situation: *The use of the EMP in the publishing industry is not popular in many countries and places where the expected EMP demand is relatively small and highly uncertain.*

On the other hand, from the studies on different correlations between the local retail market and the EMP, we have found that the amount of uncertainty towards the profit associated with the use of the EMP would depend on these demand correlations: When the demands in the two markets are positively correlated, the amount of uncertainty as measured by the standard deviation of profit is

higher; when the demands in the two markets are negatively correlated, the amount of uncertainty as measured by the standard deviation of profit is lower. In the classical mean-variance theory pioneered by the Nobel laureate Markowitz in economics (Markowitz, 1959), the risk of investment is quantified by the variance of return. Here, if we quantify the risk faced by the publisher under the buyback policy by the standard deviation of profit, then the correlation results between the local retail market's demand and the EMP's demand would give the operations manager a piece of important signal in deciding whether to implement the EMP or not. Moreover, the correlations can be estimated and found by some market observations. Some examples are as shown below.

- **Positive correlation:** When the sales of the product in the retail market is high and the product is very attractive to people who cannot buy the product at the first instance (e.g. people overseas), then the returned products, which can be sold in the EMP, would be ideal for these consumers. This accounts for a high demand in the EMP. Notice that this case can only occur when the retailers in the local retail market are not active in selling online. If the local retailers also sell online actively, they will have already satisfied the demand of the potential EMP's consumers and the positive correlation between the two demands may not hold anymore.
- **Negative correlation:** When the local market's response to the product in the retail market is low but the product is attractive to consumers in some places overseas, then the demand level of the EMP would be high. This is just the opposite of the proposed case under the positive correlation situation. Again, this case only occurs when the retailers in the local retail market are not active in selling online.

As a result, the operations manager should estimate the correlation between the demands in the two markets before making the decision about selling in the EMP or not. For example, if the EMP and the local retail market are estimated to be positively correlated and the estimated improvement in average profit brought by the EMP is low, then it is better to abandon the use of the EMP because it may lead to the situation with a small increase in average profit but a big increase of uncertainty and hence the risk of using the EMP.

CONCLUSION AND FUTURE RESEARCH

In this paper, we have carried out a simulation analysis towards a supply chain with one publisher and multiple retailers. Through the buyback policy, the publisher can maximize her average profit. The use of the EMP as a secondary market for the returned products has been proposed. We discuss the pros and cons of using the EMP under different scenarios. The impacts brought by different correlations between the demands in the local retail market and the EMP have been discussed. We find that these demand correlations do significantly affect the potential benefits of using the EMP. Through a mean-variance analysis, we propose several issues for operations managers to observe before deciding to proceed with the implementation of the EMP for selling the returned products or not. We believe that a good use of the EMP (under the favourable situations we discussed in the previous section) can bring a substantial benefit for the publisher, the retailers and the whole supply chain. Please notice that in this simulation study, we have limited our scope to a supply chain with normally distributed retail demands (uncorrelated and correlated) and fixed cost-revenue parameters in the local retail market. Although these assumptions are widely adopted in the literature, they can be limiting and further analysis can hence be made with more generalized scenarios. Moreover, future research can

be done with the consideration of the possibility of the publisher selling online and modeling a competitive game between the publisher and the retailers.

TECHNICAL APPENDIX

A1: The Optimal Retailer's Order Quantity

For given cost-revenue and distribution parameters, the retailer's ordering problem is exactly the same as the classic newsboy problem with an expected profit maximization objective (Nahmias, 1997). With the models in this paper, the optimal retailer's order quantity q_1 is given by:

$$q_i = G_i^{-1}\left(\frac{r-c}{r+h-b}\right)$$

where $G_i^{-1}(\cdot)$ is the inverse function of the cumulative distribution function for the retail demand $G_i(\cdot)$.

A2: The Optimal EMP Selling Price

In this paper, instead of setting and fixing a certain EMP selling price in advance, we would find it out dynamically with respect to the amount of returned products. It is intuitive that when the publisher receives a large amount of returned products, she would set a relatively low EMP selling price to attract more customers from the EMP to buy the product. On the other hand, if the amount of returned products is relatively small, the EMP selling price should be increased. We derive in the following the objective function for setting the optimal EMP selling price. First of all, suppose that the publisher has received L units of the returned products from the retailers and the EMP has the estimated demand distribution of

$$x_{EMP} \sim N(-K_1 r_{EMP} + K_2, \sigma_{EMP}^2).$$

Then we can express the profit from the EMP as a function of r_{EMP} as follows:

$$P_{EMP} = r_{EMP} \min(L, x_{EMP}) + (v - h_{EMP}) \max(L - x_{EMP}, 0) - C_{EMP}.$$

Since $\min(L, x_{EMP}) = L - \max(0, L - x_{EMP})$, we have:

$$\begin{aligned} P_{EMP} &= r_{EMP} L - r_{EMP} \max(L - x_{EMP}, 0) \\ &+ (v - h_{EMP}) \max(L - x_{EMP}, 0) - C_{EMP} \\ &= r_{EMP} L + (v - h_{EMP} - r_{EMP}) \\ &\times \max(L - x_{EMP}, 0) - C_{EMP}. \end{aligned}$$

Taking expectation of P_{EMP} with respect to x_{EMP} gives the expected profit, $E[P_{EMP}]$

$$\begin{aligned} E[P_{EMP}] &= r_{EMP} L + (v - h_{EMP} - r_{EMP}) \\ &\times \int_{-\infty}^L (L - x_{EMP}) f_N(x_{EMP}) dx_{EMP} - C_{EMP}. \end{aligned}$$

where

$$f_N(x_{EMP}) = N(-K_1 r_{EMP} + K_2, \sigma_{EMP}^2).$$

Thus, during the simulation experiments, when L is known after the first round of the simulation for the local retail market, the optimal selling price in the EMP which maximizes $E[P_{EMP}]$ is found by an exhaustive numerical search in the region of $1 \leq r_{EMP} \leq 25$ (with an accuracy of 1 decimal place).

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