

## Quantity discount strategies and returns policies

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### Abstract

This paper examines the relationship between a quantity discount strategy and a return policy by means of a three-stage game approach. In the first stage, the manufacturer considers how to employ a quantity discount strategy and/or a return policy. If he decides to employ a quantity discount strategy, in the second stage the manufacturer will ask the retailer to order the quantity which provides an optimal stocking level for joint profits. The buyback price is also determined by negotiation between the manufacturer and the retailer in the second stage. Finally, the manufacturer sets the wholesale price to keep his promise that the retailer's profits before and after the strategy remain the same in the third stage. In order to keep the retailer's profits unchanged, the buyback price is positively linked with the wholesale price. The quantity discount could be negative if the buyback price under the return policy is too high.

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## Introduction

The returns policies and quantity discount strategies are a common feature in the distribution channel for many years. Not surprisingly, businessmen view returns as a cost of doing business. And sellers often use a quantity discount strategy to encourage their customers to purchase higher volumes, or as a response to competition.

Given the wholesale price and the buyback price set by the manufacturer, the retailer will set the retail price and the stocking level to maximize the retailer's expected profit. Recognizing this, how would the manufacturer set his wholesale price and buyback price? Marvel and Peck (1995), followed by Lau, Lau and Willett (2000), posed the question to discuss the relationship between demand uncertainty and returns policies. Pasternack (1985) developed a return policy with channel coordination. A key result is that coordination can be achieved by allowing the retailer to return the unsold goods for a partial refund. padmanabhan and Png (1997) found that a return policy that intensifies the downstream competition and therefore leads to higher profits for the manufacturer. Emmons and Gilber (1998) observed a counterintuitive outcome that the retailer's maximizing price decreases the buyback price.

Monohan (1984) presented a quantity discount schedule in which the supplier offers a price discount to induce the retailer to increase the stocking level. Dada and Srikanth (1987) developed a quantity discount model, which can be taken as a tool for achieving channel efficiency by minimizing the system costs of the seller and buyer.

The studies mentioned above examined respectively the effect of a return policy or a quantity discount policy on the entities in the channel, but they did not consider the effect of the combination of a quantity discount strategy and a return policy, except for Su and Shi (2002). The study of Su and Shi addresses how manufacturers can design a quantity discount scheme and a return policy to achieve channel efficiency. The whole scenario made by Su and Shi is modeled by a two-stage game. In stage one, the manufacturer and the retailer determine cooperatively the inventory level, which is achieved by maximizing the joint profit. In stage two, the manufacturer bargains with the retailer for quantity discounts and return schedulers to maintain channel efficiency. Su and Shi stress that the whole game is subgame perfection.

In their model, Su and Shi assume that the wholesale price is a pre-determined parameter. We do not agree with this assumption about the wholesale price, especially when the model emphasizes that the solutions are determined by the game-theoretic approach. In other words, if the retailer makes ordering decision based on maximizing his profit, the manufacturer will also set an optimal wholesale price by maximizing his profit. It is unreasonable to assume that the wholesale price is a pre-determined parameter.

Following Su and Shi, this paper also studies how the manufacturer can design a quantity discount strategy and a return policy to achieve channel efficiency but we do not make the assumption that the wholesale price is a pre-determined parameter. The discussion is conducted following a three-stage theoretic approach. We assume that the manufacturer is the leader in the channel and the retailer is the follower. In the first stage, the manufacturer considers whether to employ a quantity discount strategy and a return policy or not. The manufacturer will implement a quantity discount strategy to encourage the retailer to have a higher stocking level if he can benefit from the strategy and not implement it if the strategy is not good for him.

If the manufacturer decides to employ a quantity discount strategy, he will ask the retailer to order a quantity that is greater than the economic order quantity, which maximizes the retailer's profit. Under a quantity strategy, the manufacturer promises the retailer that he will keep the retailer's profit before and after the strategy fixed. We find that the wholesale price in the case of a quantity discount strategy is always lower than that in the case of the economic order quantity made by the retailer. In the second stage, a return policy may be simultaneously employed at the retailer's request. If the manufacturer adopts the returns policy, then, the retailer can return all unsold products for a partial refund. The manufacturer sets the wholesale price to keep his promise that the retailer's profit before and after the strategy remains the same in the third stage. The relationship between the buyback price and quantity discount will be identified in this stage. If the manufacturer does not agree to employ these policies in the first stage, then in the second stage the manufacturer sets his optimal wholesale price and the retailer decides his optimal stocking level in the third stage.

The rest of the paper is organized as follows. The next section establishes the model in which we discover the optimal solution for

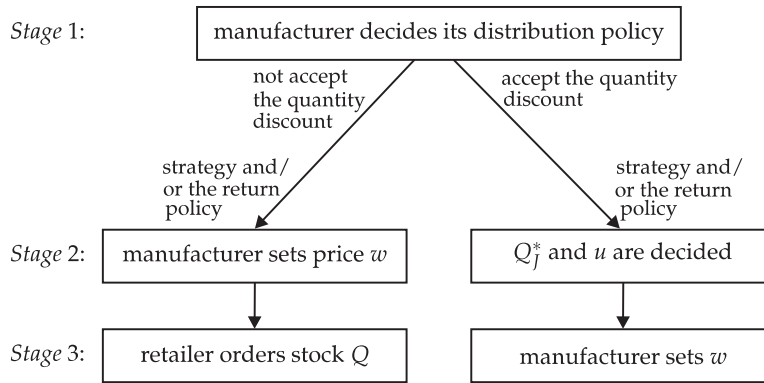
the wholesale price and the stocking level and the subsequent section provides some numerical examples to illustrate the outcomes found in the model. In the final section a brief conclusion is provided.

### The general model

There is a single upstream provider of some product which may be either a service or a good. The product has a limited shelf life because of either product obsolescence or physical decay. Hence, the product is assumed to perish if it is not sold during the selling season. We refer to the upstream entity as a manufacturer. The manufacturer must use the service of a downstream entity, whom we call a retailer, to reach the final market. The final market demand is stochastic and both parties know their respective demand distributions.

First, we present the information structure and sequence of moves (see Figure 1). The manufacturer and the retailer are independent in the channel. We assume that the manufacturer is the leader in the channel and the retailer is the follower. In the first stage, the manufacturer considers whether to employ a quantity discount strategy and a return policy or not. After consideration, the manufacturer will implement the quantity discount strategy to encourage the retailer to have a higher stocking level if he can benefit from the strategy and not to implement it if the strategy is not good for him. The use of the return policy may be triggered by the request from the retailer or may accompany the quantity discount strategy to induce the retailer to have a higher stocking level. It does not matter what is the trigger to make the quantity discount strategy happen: the most important thing is that if the manufacturer adopts the returns policy, then the retailer can return all unsold products for a partial refund, which means that  $u < w$ .  $w$  is the wholesale price set by the manufacturer and  $u$  is the buyback price which is a pre-determined parameter in the model. If he decides to employ the quantity discount strategy, in the second stage the manufacturer will ask the retailer to order the quantity,  $Q_j^*$ , which is the optimal stocking level for joint profits. To induce the retailer to accept his advice, the manufacturer gives the retailer a promise that he will keep the retailer's expected profit unchanged if the retailer's stocking level is  $Q_j^*$ . The buyback price is also determined by negotiation between the manufacturer and the retailer in the second stage. Finally, under the parameters  $Q_j^*$  and  $u$  (if the return policy is employed) the manufacturer sets the wholesale price to keep his promise that the retailer's profit before and after the strategy remains the same in the third stage.

If the manufacturer does not agree to employ these policies in the first stage, then in the second stage the manufacturer sets his optimal wholesale price and the retailer decides his optimal stocking level in the third stage. Each entity in the channel maximizes his profit by means of price or quantity.



**Figure 1**  
Sequence moves

We assume that the manufacturer’s marginal cost ( $c$ ) is constant to simplify the model. There are no other related costs for the retailer to do his business except the cost of ordering the stocking level from the manufacturer and the cost of goodwill loss occurring when his inventory level is too low for meeting the market demand.

From the outset, we assume that the manufacturer has not implemented a quantity discount strategy and a return policy. The retailer’s expected profit for all possible demand can be expressed as expected profits from the market minus the stocking costs and goodwill loss. Therefore, the expected profit function of the retailer is

$$\begin{aligned}
 E(\pi_r^1) = & p \int_0^Q x f(x) dx + p Q_1 \int_Q^{100} f(x) dx \\
 & - s \int_Q^{100} (x - Q_1) f(x) dx - w_1 Q_1, \tag{1}
 \end{aligned}$$

where  $p$ , which is determined by the market, is the retail price per item,  $s$  is goodwill loss per item.  $p$  and  $s$  are parameters in the model.  $Q$  is the stocking level ordered by the retailer from the manufacturer.  $f(\cdot)$  is the density function of market demand, and  $F(\cdot)$  is the distribution function of market demand.  $x$  is the market demand variable and we

assume that market demand is uniformly distributed within  $[0, 100]$ . That is,  $f(x) = 0.01$  and  $F(x) = 0.01x$ .

Correspondingly, the profit of the manufacturer is

$$\pi_m^1 = (w_1 - c)Q_1. \quad (2)$$

We assume that the retailer does not have bargaining power in the distribution channel. That is, the retailer just can accept or reject the manufacturer's offer, but he can not ask for more profit if the plan made by the manufacturer creates extra profit. Next, we use the backward induction of subgame perfect equilibrium to solve the optimal wholesale price for the manufacturer and the optimal stocking level for the retailer. Maximizing (1) with respect to  $Q_1$ , we can determine that the optimal stocking level for the retailer in the third stage is

$$Q_1^* = \frac{100(p + s - w_1)}{p + s}. \quad (3)$$

Similarly, maximizing (2) with respect to  $w_1$ , then, the optimal wholesale price for the manufacturer is

$$w_1^* = \frac{1}{2}(p + s + c). \quad (4)$$

Substituting (4) into (3), (3) can be rewritten as

$$Q_1^* = \frac{50(p + s - c)}{p + s}. \quad (5)$$

From (4), we know that the larger the marginal cost, the larger will be the optimal wholesale price for the manufacturer. In order to maximize his profit, it is necessary for the manufacturer to increase his wholesale price as his marginal cost increases. We also can know from (5) that the larger the marginal cost, the smaller will be the optimal stocking level for the retailer. Obviously, the retailer will decrease his optimal stocking level due to the increase in the wholesale price. Equation (4) also tells us that the larger the goodwill loss per item for the retailer, the larger will be the optimal wholesale price for the manufacturer. From (5) we can find the reason why the larger goodwill loss per item will lead the manufacturer to increase his wholesale price. That is, the retailer will increase his optimal stocking level as the goodwill loss per item becomes large in order to keep his reputation or make more profit. Therefore, even with a larger wholesale price, the retailer will still increase his stocking level. The case of the retail price is the same as the case of goodwill loss. The increase in the retail price will

increase the retailer's stocking level, which will cause the wholesale price to rise. Hence, the relationship between the two prices is positive.

Next, we suppose that the manufacturer plans to design an adequate incentive scheme to entice the retailer to change his ordering decisions. The manufacturer advises the retailer to increase his stocking level from  $Q_1^*$  to  $Q_J^*$ . To induce the retailer to accept his advice, the manufacturer gives the retailer a promise that he will keep the retailer's expected profit unchanged if the retailer's stocking level is  $Q_J^*$ . First, we have to find the solution of  $Q_J^*$ . Let  $\pi_J$  represent the joint profit of the manufacturer and retailer, which is  $\pi_J = \pi_r^2 + \pi_m^2$ . Therefore, the expected joint profit can be expressed as

$$E(\pi_J) = p \int_0^Q xf(x)dx + pQ_J \int_Q^{100} f(x)dx - s \int_Q^{100} (x - Q_J)f(x)dx - w_2Q_J. \tag{6}$$

To find the optimal inventory level,  $Q_J^*$ , we set  $\partial E(\pi_J)/\partial Q_J = 0$ . We can determine the optimal inventory level as

$$Q_J^* = \frac{100(p + s - c)}{p + s}. \tag{7}$$

The manufacturer promises that he will keep the retailer's expected profit unchanged if the retailer's stocking level is  $Q_J^*$ . First, we assume that the manufacturer just uses a quantity discount strategy to keep the retailer's expected profit unchanged. We denote the wholesale price as  $w_2$  under the quantity discount strategy. Hence, the expected profit for the retailer is

$$E(\pi_r^2) = p \int_0^Q xf(x)dx + pQ_J \int_Q^{100} f(x)dx - s \int_Q^{100} (x - Q_J)f(x)dx - w_2Q_J. \tag{8}$$

Therefore, we obtain the condition,  $(8) = (1)$ , since the expected profit for the retailer is unchanged when he changes his stocking level from  $Q_1^*$  to  $Q_J^*$ . According to the condition,  $(8) = (1)$ , the wholesale price  $w_2$  is

$$w_2^* = \frac{1}{8}(3p + 3s + 5c). \tag{9}$$

Hence, when the retailer increases his stocking level, then the wholesale price facing the retailer must decrease in order to keep the retailer's ex-

pected profit unchanged. The above-mentioned conclusion can be shown as follows.

$$w_1^* - w_2^* = \frac{1}{8}(p + s - c).$$

Since  $p > c$ , then  $w_1^* > w_2^*$ . The conclusion is very intuitive. Because the retailer faces uncertain demand, the increased stocking level will increase his risk. Hence, the wholesale price set by the manufacturer must decrease to induce the retailer to accept the higher stocking level. We can see that the relationship between the wholesale price discount and marginal cost is negative. In contrast, the relationship between the wholesale price discount and goodwill loss (or retail price) is positive.

Next, we want to show how the manufacturer has an incentive to induce the retailer to order the stocking level  $Q_J^*$ , which is the optimal stocking level for the joint profits, by implementing a quantity discount strategy. If the retailer orders the stocking level  $Q_J^*$ , the profit for the manufacturer is

$$\pi_m^2 = (w_2 - c)Q_J^*, \quad (10)$$

and

$$\pi_m^2 - \pi_m^1 = \frac{1}{8}[(p + s - c)Q_J^*] > 0.$$

Obviously, if the retailer's profits before and after the quantity discount strategy remain the same, then the manufacturer's profit will increase after the strategy. Therefore, the manufacturer has an incentive to induce the retailer to order the stocking level  $Q_J^*$  by implementing a quantity discount strategy.

Subsequently, we deal with the effect of a return and quantity discount strategy on the manufacturer's profit. Under this situation, the stocking level ordered by the retailer from the manufacturer is still  $Q_J^*$ . But now, to entice the retailer to the volume, the manufacturer not only employs a quantity discount strategy, but also implements a return policy that allows the retailer to return any unsold goods. Hence, the expected profit for the retailer is

$$\begin{aligned} E(\pi_r^3) = & p \int_0^Q x f(x) dx + p Q_J^* \int_Q^{100} f(x) dx \\ & - s \int_Q^{100} (x - Q_J^*) f(x) dx + u \int_0^Q (Q_J^* - x) f(x) dx - w_3 Q_J^*. \quad (11) \end{aligned}$$

and the manufacturer's expected profit is

$$\pi_m^3 = (w_3 - c)Q_J^* - u \int_0^{Q_J^*} (Q_J^* - x)f(x)dx. \tag{12}$$

Similarly, unless the profit for the retailer in the case in which a return and quantity discount strategy is employed is not lower than that without the strategy, the retailer will not accept the strategy offered by the manufacturer. Therefore, we set

$$\pi_r^3 = \pi_r^2 = \pi_r^1.$$

Given this condition, the solution of  $w_3$  is determined as

$$\begin{aligned} w_3^* &= w_2^* + u \frac{Q_J^*}{200} \\ &= \frac{1}{8}(3p + 3s + 5c) + \frac{u(p + s - c)}{2(p + s)}. \end{aligned} \tag{13}$$

Substituting (13) into (12), we obtain  $\pi_m^3 = \pi_m^2$ . Since  $\pi_m^2 > \pi_m^1$ , so  $\pi_m^3 > \pi_m^1$ . That is, given the stocking level  $Q_J^*$  and to keep the retailer's profit unchanged, the profit for the manufacturer will increase in either of the two cases compared to the case in which no policy is implemented.

Following Su and Shi (2002), the quantity discount can be expressed as

$$\begin{aligned} \Delta w &= w_1^* - w_3^* = w_1^* - w_2^* - u \frac{Q_J^*}{200} \\ &= \frac{(p + s - c)}{8(p + s)}(p + s - 4u). \end{aligned} \tag{14}$$

Just as Su and Shi's view, all feasible sets of  $(\Delta w, u)$  combinations, as expressed in (14) will satisfy the Pareto efficiency. However, what makes us even more curious is the order of the wholesale prices in the two situations — one is to execute a return and quantity discounts policy and the other is not to execute the policy under various values of  $u$ . From Equation (14), we can obtain the following conclusion:

$$\begin{aligned} w_1^* &> w_3^* && \text{if } p + s > 4u, \\ w_1^* &= w_3^* && \text{if } p + s = 4u, \\ w_1^* &< w_3^* && \text{if } p + s < 4u. \end{aligned}$$

**Proposition 1.** *The wholesale price under the combination of a quantity discount strategy and a return policy is higher, equal, lower than that under no policy if  $p + s$  is lower, equal, higher than  $4u$ .*

If  $u = 0$ , that is, the manufacturer does not accept the return policy, the wholesale price in this scenario with a quantity discount contract is always lower than that without such contract. But if  $u > 0$ , the wholesale price in the quantity discount scenario could be higher than its counterpart. That is, the quantity discount could be negative in the case of a quantity discount scheme accompanied with a return policy.

Besides, from (13), we know the variable relationship between the wholesale price and the buyback price to be as follows.

$$\frac{\partial w_3^*}{\partial u} = \frac{(p + s - c)}{2(p + s)} > 0. \quad (15)$$

**Proposition 2.** *To keep the retailer's profit unchanged like that in the situation in which no quantity discount strategy nor any return policy is employed, the higher the buyback price, the higher will be the wholesale price.*

It is natural that the manufacturer responds with a higher wholesale price to accept the returns when the retailer requests to an increase in the buyback price. From (15), we find that, in order to remain the retailer's profit unchanged, the amount of increase in the buyback price is one dollar whereas that of the increase in the wholesale price is less than half a dollar. But it is possible for the wholesale price in the return-quantity discount contract to be higher than that without any contract when the buyback price is too high.

Differentiating Equation (14) with respect to  $c$ , then

$$\frac{\partial(w_1^* - w_3^*)}{\partial c} = -\frac{(p + s - 4u)}{8(p + s)} < 0.$$

That is, the difference between  $w_1^*$  and  $w_3^*$  becomes smaller as the marginal cost becomes bigger. Similarly, differentiating Equation (14) with respect to  $p$  and  $s$ , respectively, we can get the following conditions:

$$\begin{aligned} \frac{\partial(w_1^* - w_3^*)}{\partial p} &= \frac{(p + s)^2 - 4uc}{8(p + s)^2}, \\ \frac{\partial(w_1^* - w_3^*)}{\partial s} &= \frac{(p + s)^2 - 4uc}{8(p + s)^2}. \end{aligned}$$

That is,  $\partial(w_1^* - w_3^*)/\partial p >, =, < 0$  and  $\partial(w_1^* - w_3^*)/\partial s >, =, < 0$  if  $p + s >, =, < 2\sqrt{uc}$ . Although each of the three factors can affect the difference between  $w_1^*$  and  $w_3^*$ , the marginal cost for the manufacturer has nothing to do with the order of  $w_1^*$  and  $w_3^*$ .

In this paper, we assume that the retailer does not have bargaining power in the distribution channel. Accordingly, the whole extra gain due to  $Q_j^*$  which is the optimal stocking level for the joint profit, is taken by the manufacturer. Under this situation, we discover the following proposition.

**Proposition 3.** *If the retailer does not have bargaining power in the distribution channel, there are three factors to determine whether the quantity discount is positive or negative. These three factors are retail price, goodwill loss and the buyback price. In other words, the marginal cost for the manufacturer has nothing to do with the order of  $w_1^*$  and  $w_3^*$ .*

**Numerical illustration**

This section presents a numerical example to illustrate the previous outcome. Assume that  $p = 180, s = 20, c = 60$ . Under these parameters, we can determine that the optimal wholesale price  $w_1^*$  is 130 and the optimal stocking level  $Q_1^*$  is 35 if the manufacturer does not have a quantity discount strategy or a return policy. Substituting the relevant parameters into (1) and (2), then, we obtain  $\pi_m^1 = 2450$  and  $E(\pi_r^1) = 225$ . Revenues for the manufacturer and the retailer, production cost, wholesale cost and goodwill loss are listed in Table 1.

**Table 1**  
 $u = 0$  and  $Q_1^* = 35$

	Manufacturer	Retailer
Revenue	4550	5197.5
production cost	(2100)	
Wholesale cost		(4550)
Goodwill loss		(422.5)
Profit	2450	225
Joint profit	2675	

Next, we assume that the manufacturer implements a quantity discount strategy but no return policy in the first stage. In the second stage, the optimal stocking level  $Q_j^*$  is determined as 70. In this situation, at the third stage the manufacturer sets his price equal to 112.5. If the manufacturer asks the retailer to place an order of  $Q_1^* = 70$ , then the joint profit is higher than that of  $Q_1^* = 35$ . Of course, the profit for the manufacturer is higher in the former than in the latter. In order to keep the retailer's profit unchanged, the wholesale price made by the manufacturer must decrease from 130 to 112.5. The retailer's loss due to

altering the order is offset by the decreased wholesale price. The relevant information is listed in Table 2.

**Table 2**  
 $u = 0$  and  $Q_1^* = 70$

	Manufacturer	Retailer
Revenue	7875	8190
production cost	(4200)	
Wholesale cost		(7875)
Goodwill loss		(90)
Profit	3675	225
Joint profit	3900	

Next, we assume that the manufacturer not only employs a quantity discount strategy, but also employs a return policy with  $u = 40$ . At stage 2, the stocking level  $Q_1^*$  and the buyback price are given as 70 and 40, respectively. Substituting relevant into Equation (13), the wholesale price is resolved as 126.5 in the third stage. It is easy to see that the quantity discount is positive ( $130 - 126.5 = 3.5$ ). It is also easy to see that the quantity discount is negative when  $u$  is larger than 45. The profit for the retailer is unchanged from the case with  $u = 0$  and  $Q_1^* = 70$  to the case with  $u = 40$  and  $Q_1^* = 70$ . It is evident that the retailer's loss due to altering the order is partly offset by the return policy. Similarly, the manufacturer's revenue is partly offset by the return policy. In order to keep the retailer's profit unchanged,  $w^*$  must increase if  $u$  increases. That is, the buyback price  $u$  is positively associated with the wholesale price,  $w^*$ . The joint profit reaches a peak at 3900 when the manufacturer and retailer are vertically integrated within the system.

**Table 3**  
 $u = 40$  and  $Q_1^* = 70$

	Manufacturer	Retailer
Revenue	8855	8190
production cost	(4200)	
Wholesale cost		(8855)
Goodwill loss		(90)
Loss from return	(980)	
Gain from return		980
Profit	3675	225
Joint profit	3900	

### Conclusion

This paper studies the relationship between a quantity discount strategy and a return policy by means of a three-stage game approach. In the first stage, the manufacturer considers how to employ a quantity discount strategy and/or a return policy to increase his profits without increasing the retailer's costs. If he decides to employ the quantity discount strategy, in the second stage the manufacturer will ask the retailer to order the quantity which is the optimal stocking level for joint profits. The buyback price is also determined by the negotiation between the manufacturer and the retailer in the second stage. Finally, the manufacturer sets the wholesale price to keep his promise that the retailer's profit before and after the strategy remains the same in the third stage. If the manufacturer does not agree to employ these policies in the first stage, then in the second stage the manufacturer sets his optimal wholesale price and the retailer decides his optimal stocking level in the third stage.

In this paper, we find that, in order to keep the retailer's profit unchanged, the buyback price is positively associated with the wholesale price. That is, the larger the buyback price asked by the retailer, the larger will be the wholesale price set by the manufacturer. Given the relationship between the buyback price and wholesale price, the quantity discount could be negative if the buyback price is too high. If the buyback price is higher than a quarter of the sum of the retail price and goodwill loss, the discount for replenishing the stock of merchandizing will become negative.

It is a shortcoming to assume that the retailer does not have bargaining power in the distribution channel. Accordingly, the manufacturer takes the whole extra gain that is created by the optimal stocking level for joint profits. If it is not the case, the development in this paper could be different. This could be regarded as a topic for future research.

### References

- [1] M. Dada and K. N. Srikanth (1987), Pricing policies for quantity discount, *Management Science*, Vol. 33, pp. 1247–1252.
- [2] H. Emmons and S. M. Gilber (1998), Note: the role of returns policies in pricing and inventory decisions for catalogue goods, *Management Science*, Vol. 44, pp. 276–283.
- [3] A. H. L. Lau, H. S. Lau and K. D. Willett (2000), Demand uncertainty and returns policies for a seasonal product: an alternative model, *International Journal of Production Economics*, Vol. 66, pp. 1–12.

- [4] H. P. Marval and J. Peck (1995), Demand uncertainty and returns policies, *International Economics Review*, Vol. 36, pp. 691–714.
- [5] J. P. Monohan (1984), A quantity discount pricing model to increase vender profits, *Management Science*, Vol. 30, pp. 720–726.
- [6] B. A. Pasternack (1985), Optimal pricing and returns policies for perishable commodities, *Marketing Science*, Vol. 4, pp. 166–176.
- [7] C. T. Su and C. S. Shi (2002), A manufacturer's optimal quantity discount strategy and return policy through game-theoretic approach, *Journal of the Operational Research Society*, Vol. 53, pp. 922–926.

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