Economic order quantity under advance payment

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A B S T R A C T

Though advance payment is widely used in practice, its influences on buyer's inventory policy are rarely discussed. This paper investigates the buyer's inventory policy under advance payment, including all payment in advance and partial-advanced–partial-delayed payment. The buyer's ordering policy is derived by minimizing his total inventory costs including inventory holding cost, ordering cost, and interest cost caused by advance payment or delayed payment. The conclusions show that when all the payment is paid in advance, the buyer's optimal replenishment cycle is influenced only by the price discount associated with advance payment, and the length of advance payment has no effect. For the partial-advanced–partial-delayed payment case, the buyer's replenishment cycle is also not influenced by the length of advance period. However, in this situation, the delayed period and the price discount may have impacts on the inventory policy. We also use discounted cash flow (DCF) model to derive the buyer's replenishment cycle and show that the replenishment cycle is negatively related to the length of advance period. Numerical examples are presented to illustrate the results.

1. Introduction

In real world, transactions between firms seldom complete instantaneously. When a seller is powerful and wants to control the risk of the cash flow, he would like the buyer to pay in a fixed period before the date of delivery. Sometimes, all of the payment is paid in advance, while in other situations, only part of the payment is paid in advance. Partial advance payment is used to control the risk of buyer's canceling order or to finance the procurement of material or parts used in production of the ordered product. In Chinese automobile industry, advance payment to the manufacturer is a common practice for the 4S (sale, spare-part, service, and survey) stores who are required to pay all of the payment before delivery. In Chinese steel industry, huge steel plants also require advance payment, especially for small buyers. Sometimes, the buyer is offered a price discount if he/she gives advance payment even not required by the seller, such cases can be found in bricks and tile factories in India [1]. When the payment is paid in advance, the vendor benefits from the cash deposit since the advance payment from the customer can be taken as an interest-free loan.

On the contrary, some vendors offer their buyers a delay period in purchasing payment. Therefore, before the end of delay period, buyers can sell the goods and accumulate revenue and earn interest. It is a very common policy used by vendors to promote their commodities.

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The buyer's inventory policies under delayed payment have been widely addressed. Goyal [2] was the first to consider the vendor's delayed payment in analyzing the buyer's economic order quantity (EOQ). Following Goyal's work, lots of papers addressed the same or similar issues under more general settings. For perishable products, the buyer's optimal order quantity under delayed payment was studied by Aggarwal and Jaggi [3], Jamal et al. [4], Ouyang et al. [5], Musa and Sani [6], Liao et al. [7], etc., Hwang and Shinn [8], Arcelus et al. [9], Abad and Jaggi [10] and Thangam and Uthayakumar [11] took the price-sensitive demand into consideration. According to Teng et al. 12 and Chung [13], the final demand was a linear nondecreasing function of time. Ouyang et al. [14], Goyal et al. [15], Ho et al. [16], Sana and Chaudhuri [17] introduced two-part terms of delayed payment into their models. Two-part terms of delayed payment imply that the buyer can get some cash discount when he/she pays the vendor in the discount period, otherwise the buyer should pay all of the payment before the due date.

Huang [18,19], Teng et al. [20], and Tsao [21], considered two levels of trade credit policy in which the supplier offered the retailer a permissible delay period M, and the retailer also provided its customer a permissible delay period N. Recently, Taleizadeh et al. [22] and Guria et al. [23] considered an EOQ problem under partial delayed payment. Chung and Liao [24,25] and Chang et al. [26] presented the discounted cash flow (DCF) approach for analysis of the optimal inventory policy in the presence of the trade credit.

Instead of setting the delayed payment as a given policy, some papers set trade credit as a decision variable and discussed the effect of delayed payment on coordinating supply chain. Jaber and Osman [27], Luo [28], and Chan et al. [29] explicitly used trade credit as a mechanism to coordinate a buyer–vendor supply chain under different settings.

Although the influences of delayed payment on inventory policies have attracted great attention, the advance payment and its influences on inventory decisions are rarely addressed. Maiti et al. [1] considered the advance payment and developed an inventory model for one item in stochastic environment with price-dependent demand over a finite time horizon. In their model, the buyer's procurement price was assumed to be dependent on the fraction of the advance payment. However, the payment scheme seemed to be just an additional factor to make the model more realistic and not the core topic of the paper. Gupta et al. [30] further extended the model by considering the imprecise information of the cost. Thangam [31] incorporated the advance payment scheme and two-echelon trade credits into an EOQ model for perishable items. Both the retailer's optimal inventory policy and the price discount for advance payment are derived. However, according to Thangam [31], the advance payment was used between the final customer and the retailer, and the vendor still offered full delayed payment to the retailer, while in our paper, the advance payment is used between the buyer and the vendor, and we consider two types of advance payment, i.e., all payment paid in advance and partial advance payment.

In this paper, we first study the buyer's optimal replenishment cycle when all of the payment is paid in advance. Then, we address the same issue when partial payment is in advance and the rest in delayed form. After that we use DCF model to analyze the optimal replenishment cycle when all of the payment is paid in advance. Our findings show that under the same assumptions as the traditional EOQ model, when all of the payment is paid before delivery, it is not the length of advance period but the price discount associated with advance payment that has impact on the buyer's optimal replenishment cycle. For the case of partial-advanced–partial-delayed case, the buyer's replenishment cycle is also not influenced by the length of advance period. That is, only the length of the period of advance payment has impact on the buyer's and the vendor's costs. However, the buyer's replenishment cycle derived by the DCF model is negatively related to the length of advance period.

2. Assumptions and notation

In this paper, the following assumptions are made to derive the optimal inventory policies.

(1) Demand for the item is constant with time.
(2) Shortages are not allowed.
(3) Time horizon is infinite.
(4) Replenishments are instantaneous.
(5) The vendor offers price discount for the buyer if all or part payment is paid in advance.
(6) The buyer's unit purchasing price is different from the sell price.
(7) During the time the purchase cost has been paid and the account has been settled, the payment generates interest cost, and the interest cost will decrease with the sales revenue depositing in an interest-bearing account. The sales revenue will also generate interest income when it is greater than the advance payment.

In a word, most of the assumptions are the same as those in the traditional EOQ model except that the payment is made in different settings.

In addition, the following notations are used throughout this paper.

D	demand rate
h	unit stock-holding cost per item per unit time excluding interest charges
p	unit purchase price in $