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Retailer's decision for ordering and credit policies for deteriorating items when a supplier offers order-linked credit period or cash discount

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ABSTRACT

In this study, the retailer's decision for ordering and credit policies is analyzed when a supplier offers its retailer either a cash discount or a fixed credit period if the order quantity is greater than or equal to regular order policy. Then the retailer offers credit period to its customer which increases the demand and default risk and decreases profit. Furthermore, the units in the retailer's inventory system deteriorate at a constant rate. Some theoretical results are derived to compute the optimal solution. The theoretical results are supported by numerical examples. The managerial acumens are provided.

1. Introduction

Since Goyal [8] article, researchers are busy in exploring and analyzing the impacts of the promotional tools offered by the supplier to the retailer in inventory management. In this context, Shah et al. [27] gave up to date review of articles available in literature on trade credit. In most of the articles cited in this review article considered credit period for any order. For example, Chang et al. [2] and Gor and Shah [7] have formulated an economic order quantity inventory model for deteriorating items under supplier's credit linked to order quantity. On the other hand, Chung and Huang [3] have analyzed the effect of finite production on an economic production quantity inventory model with delay in payments. At the same time, Huang [9] have developed a two-level credit period model where the supplier offers a credit period to retailer which in turn passed on to the customer by the supplier. Other relevant papers related on credit financing are by Misra and Shah [11,12], Shah and Shukla [19–21], Shah et al. [22,23,25,24], Shah [15–17], Shah and Raykundaliya [18] and their references. Additional research studies in this topic can be found in Chen et al. [4], Chung et al. [5], Wu et al. [29], Ouyang et al. [13], Chung and Cárdenas-Barrón [6], just to name a few recent works.

In all above cited articles, a fixed credit period offered by the supplier to the retailer is assumed and retailer is the unique decision maker. Very few articles are available in the inventory literature and these consider the credit period as decision variable. In this direction, Abad and Jaggi [1] proposed the seller's and the buyer's policies under independent and joint decisions. Basically, they established that the seller is not beneficial to offer a trade credit to the buyer. Later on Jaggi et al. [10] and Shah et al. [26] formulated the optimal ordering and credit policies for the seller when the credit period has positive

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impact on demand. However, both articles have missed out the default risk for the longer credit period. Within this context, Teng and Chang [28] developed an EOQ model by incorporating default risk in offering credit period.

In this paper, we proposed an inventory model with the following business strategies: (1) the supplier offers the retailer a cash discount or a permissible delay payment linked to order quantity; and (2) the retailer passes its buyer a delay payment facility which has a positive impact on demand and a default risk but with negative impact on profit. Then some theoretical results are provided to determine the optimal credit period and cycle time for the retailer under different scenarios. Based on theoretical results, an algorithm is developed which helps the retailer to make advantageous decision. Finally, some numerical examples are given to illustrate the theoretical results and managerial acumens are drawn.

The rest of this paper is organized as follows. Section 2 introduces the notation and assumptions of the inventory model. Section 3 formulates the inventory model mathematically. Section 4 makes an analytic análisis and develops a solution procedure to obtain the optimal solution the proposed inventory model. Section 5 illustrates the use of the solution procedure through numerical examples and conducts a sensitivity analysis. Finally, Section 6 provides some conclusions and establishes some potential future research direction.

2. Notation and assumption

2.1. Notation

The following notation is used in the development of the proposed inventory model:

A	the retailer's ordering cost per order
C	the retailer's purchase cost per unit
P	the retailer's selling price per unit; with $P > C$
h	the retailer's unit holding cost per year excluding interest charges
I_e	the interest earned \$ per year
I_c	the interest charged \$ per year; with $I_c > I_e$
M	the trade credit period in years offered by the supplier to the retailer
r	the cash discount rate offered by the supplier to the retailer; $0 \leqslant r < 1$
W	pre-specified order quantity for which trade credit is permitted
T_W	the time period at which W – units get sold
N	the trade credit period in years offered by the retailer to the customer (a decision variable)
$R(N)$	$(= a(1 + bN))$; the annual demand rate which is function of N where a is a scale demand, b denotes rate of change of demand because of credit offer and $a, b > 0$.
T	the retailer's cycle time in years (a decision variable)
Q	the retailer's order quantity (a decision variable)
θ	constant deterioration rate; $0 \leqslant \theta < 1$
τ	default risk rate; $0 < \tau \leqslant 1$
$TP(N, T)$	the retailer's total profit per unit time
N^*	the optimal credit period offered by the retailer to the customer
T^*	the optimal cycle time
Q^*	the optimal order quantity
TP^*	the maximum profit of the retailer

2.2. Assumptions

1. The inventory system under consideration deals with a single item.
2. The demand rate; $R(N)$ depends on the credit period offered by the retailer to the customer and is given by $R(N) = a(1 + bN)$ where a and b are positive constants.
3. The replenishment rate is infinite.
4. The shortages are not allowed and lead-time is zero.
5. The units in inventory deteriorate at a constant rate, $0 \leqslant \theta < 1$. The deteriorated units can neither be repaired nor replaced during the cycle time.
6. The retailer has the following two options (1) trade credit linked to order quantity; and (2) a cash discount. If the retailer's order quantity is greater than or equal to pre-specified quantity, W – units then he or she qualifies for the delayed payment and he or she must settle the account by time M. On the other hand, if retailer chooses the option of cash discount, then the outstanding amount must be paid immediately on the arrival of the items.
7. During the credit period M, the retailer can incur interest on the generated sales revenue. At the end of the delay period, the retailer settles the account for all purchase and starts paying interest charges for the unsold items.