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# Optimal payment time for a retailer under permitted delay of payment by the wholesaler

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## Abstract

The retailer (buyer) is usually allowed a permissible credit period to pay back the dues without paying any interest to the wholesaler (supplier). In this problem the retailer can pay the wholesaler either at the end of credit period or later incurring interest charges on the unpaid balance for the overdue period. This research develops a retailer's model for optimal cycle and payment times for a retailer in a deteriorating-item inventory situation where a wholesaler allows a specified credit period to the retailer for payment without penalty. Under these conditions, this wholesaler-and-retailer system is modeled as a cost minimization problem to determine the optimal payment time under various system parameters. The model is solved through an iterative search procedure and the overall findings indicate that the retailer has always an option to pay after the permissible credit period depending on interest rates, unit purchase and selling price, and the deterioration rate of the products. © 2000 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

In a typical buyer–seller situation, an inventory model considers a case in which depletion of inventory is caused by a constant demand rate, but in real-life situations there is inventory loss by deterioration also. This paper considers a retailer's model in which the deterioration rate is constant, and the retailer has an option to fix the payment

period instead of settling the account with the wholesaler (supplier) at a particular allowable time frame.

In today's competitive business transactions, it is common to find that the retailers (buyers) are allowed some credit period before they settle the account with the wholesaler. This provides a very big advantage to the customers, due to the fact that they do not have to pay the wholesaler immediately after receiving the product, but instead, can delay their payment until the end of the allowed period. The customer pays no interest during the permissible time for payment, but interest will be charged if the payment is delayed beyond that period.

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A lot of work has been done on deteriorating inventory systems [1–7]. Heng et al. [5] integrated Misra's [1] and Shah's [2] models to consider a lot-size, order-level inventory system with finite replenishment rate, constant demand rate, and exponential decay. Su et al. [8] considered an inventory under inflation for stock dependent consumption rate and exponential decay while Hariga [6,9] developed models for deteriorating items with time-dependent demand.

Kim et al. [10] developed an optimal credit policy to increase wholesaler's profits with price-dependent demand functions. Goyal [11] developed an economic order quantity under the conditions of permissible delay in payments for an inventory system. Aggarwal and Jaggi [12] developed a model to determine the optimum order quantity for deteriorating items under a permissible delay in payment. Hwang and Shinn [13] modeled an inventory system for retailer's pricing and lot sizing policy for exponential deteriorating products under the condition of permissible delay in payment. Other researchers also considered similar issues relating to payment period or lot sizing [14–19].

### 1.1. The wholesaler-and-retailer problem

The retailer pays neither the interest nor the purchase price of the items to the wholesaler before the permissible credit period expires. The retailer is subjected to pay the interest on the purchase amount if the account is not settled before the permissible credit (delay) period expires. The reason for offering a credit period to the retailers is to stimulate the demand. The wholesaler usually expects that the interest loss incurred during the credit period can be compensated by the increase in profit due to stimulated sales.

From a wholesaler's point of view, an important question is how to set a credit period, and from the retailer's point of view, the question is how to take the advantage of the credit period as well as his payment time. An ordering policy for deteriorating items with allowable shortage, and permissible delay in payment is studied by Jamal et al. [20], but it does not seek for an optimal payment period. Assuming that the permissible credit period is already

set by wholesalers on the basis of trade practice, with infinite replenishment rate and no shortages of products, the problem in this research is to ascertain the *optimal payment period* for the retailer to minimize the total cost of the inventory system. This paper finds an optimal payment time for an inventory system with deteriorating items under a condition that the wholesaler offers a permissible credit period for payment after the purchase of the goods.

## 2. The retailer and wholesaler's payment system

In this problem the retailer can pay the wholesaler either at time  $M$  to avoid the interest payment or afterwards with interest on the unpaid balance due at  $M$ . Typically, the retailer may not pay fully the wholesaler by time  $M$  for lack of cash. On the other hand, his cost will be higher the longer he waits beyond  $M$ . Therefore, the retailer will gradually pay the wholesaler until the payment is complete. Since the selling price is higher than the unit cost, and interest earned during the credit period  $M$  may also be used to pay off the wholesaler, the payment will be complete at time  $P$  before the end of each cycle  $T$  (i.e.,  $M \leq P \leq T$ ).

This wholesaler and retailer system is modeled as a cost minimization problem to determine the optimal payment time  $P^*$  under various system parameters. Both credit period and payment period in this system is depicted along with the inventory level in Fig. 1. The following assumptions and notation are used throughout the paper.

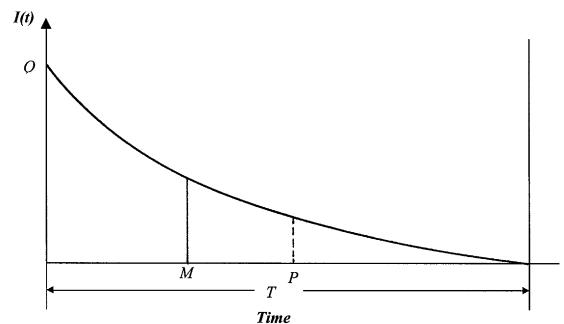


Fig. 1. The wholesaler and retailer's deteriorating inventory system.

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