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Optimal ordering policies for a retailer who offers distinct trade credits to its good and bad credit customers

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Abstract

In practice, to reduce default risks, a retailer frequently offers its bad credit customers a partial trade credit, in which the retailer requests its customers to pay a portion of the purchase amount at the time of placing an order as a collateral deposit, and then grants a permissible delay on the rest of the purchase amount. By contrast, the retailer usually provides a full trade credit to its good credit customers without the collateral deposits. For generality, in this paper, I establish an economic order quantity (EOQ) model for a retailer who receives a full trade credit by its supplier, and offers either a partial or a full trade credit to its customers. The proposed model is in a general framework that includes numerous previous models as special cases. I then analyze the characteristics of the optimal solution, and provide an easy-to-use closed-form optimal solution. Finally, I use a real-world inventory problem to illustrate the proposed model and its optimal solution.

Introduction

In the classical inventory economic order quantity (or EOQ) model, it was assumed that the retailer must pay for the items as soon as receiving them. In practice, a supplier frequently offers a retailer a delay of payment (i.e., an up-stream trade credit) for settling the amount owed to him. Usually, there is no interest charge if the outstanding amount is paid within the permissible delay period. However, if the payment is not paid in full by the end of the permissible delay period, then interest is charged on the outstanding amount. Therefore, it is clear that a retailer will delay the payment up to the last moment of the permissible period allowed by the supplier. The permissible delay in payments produces two benefits to the supplier: (1) it attracts new buyers who consider it to be a type of price reduction, and (2) it may be applied as an alternative to price discount because it does not provoke competitors to reduce their prices and thus introduce lasting price reductions. On the other hand, the policy of granting credit terms adds not only an

additional cost but also an additional dimension of default risk to the supplier. Similarly, a retailer may offer its customers a permissible delay (i.e., a down-stream trade credit) to settle the outstanding balance.

Goyal (1985) developed an EOQ model under conditions of permissible delay in payments. He ignored the difference between the selling price and the purchase cost. Although Dave (1985) corrected Goyal's model by addressing the fact that the selling price is necessarily higher than its purchase cost, his viewpoint did not draw much attention to the recent researchers. Aggarwal and Jaggi (1995) extended Goyal's model to consider the deteriorating items. Jamal et al. (1997) further generalized Aggarwal and Jaggi's model to allow for shortages. Hwang and Shinn (1997) added the pricing strategy to the model, and developed the optimal price and lot sizing for a retailer under the condition of permissible delay in payments. In contrast to all above models, Jamal et al. (2000) and Sarker et al. (2000a) obtained the optimal cycle and payment times for a retailer when a supplier offers a specified credit period for payment without penalty. Teng (2002) amended Goyal's model by considering the difference between unit price and unit cost, and found that it makes economic sense for a well-established buyer to order less quantity and take the benefits of the permissible delay more frequently. Chang et al. (2003) developed an EOQ model for deteriorating items under supplier credits linked to ordering quantity. Chung and Huang (2003) developed an EPQ inventory model for a retailer when the supplier offers a permissible delay in payments. Huang (2003) extended Goyal's model to develop an EOQ model in which the supplier offers the retailer the permissible delay period M, and the retailer in turn provides the trade credit period N (with $N \leqslant M$) to his/her customers. Recently, Teng and Goyal (2007) complemented the shortcoming of Huang's model and proposed a generalized formulation. Many related articles can be found in Chang and Teng (2004), Chang and Dye (2001), Chung and Liao (2004), Goyal et al. (2007), Huang, 2004, Huang, 2007, Huang and Hsu (2008), Liao et al. (2000), Khouja and Mehrez (1996), Ouyang et al., 2005, Ouyang et al., 2006, Sarker et al. (2000b), Shinn and Hwang (2003), Teng and Chang (2009), Teng et al., 2007, Teng et al., 2006, Teng et al., 2005, and their references.

To reduce default risks, in practice, a retailer frequently offers a partial down-stream trade credit to its credit risk customers who must pay a portion of the purchase amount at the time of placing an order as a collateral deposit, and then receive a permissible delay on the rest of the outstanding amount. In contrast, the retailer usually provides its good credit customers a full trade credit without the collateral deposit. In this paper, I first establish an EOQ model for a retailer who receives a full trade credit by its supplier, and offers either a partial trade credit to its bad credit customers or a full trade credit to its good credit customers. My proposed model is in a general framework that includes numerous previous models such as Goyal (1985), Teng (2002), Huang (2003), Teng and Goyal (2007), and others as special cases. In addition, the proposed model provides the optimal ordering policies for a retailer not only to its bad credit customers but also to its good credit customers. I then derive the theoretical results of the optimal solution, and provide an easy-to-use closed-form optimal solution. Finally, I use a real-world inventory problem to illustrate the proposed model and its optimal solution.

Section snippets

Notation and assumptions

The following notation is used throughout the entire paper:

D	the annual demand rate
A	the ordering cost per order
c	the purchasing cost per unit
p	the selling price per unit, with $\boldsymbol{p > c}$
h	the unit holding cost per year excluding interest charge
$\boldsymbol{I_e}$	the interest earned per dollar per year
$\boldsymbol{I_c}$	the interest charged per dollar per year
α	the fraction of the purchase cost in which the customer must pay the retailer at the time of placing an order, with $0 \leqslant \alpha \leqslant 1$
$1-\alpha$	the portion of the purchase cost in which the retailer

…

Mathematical models

From the values of N and M, we have two potential cases: (1)$N \leqslant M$ and (2) $N \geqslant M$.

Case 1. $N \leqslant M$

Based on the values of M (i.e., the time at which the retailer must pay the supplier to avoid interest charge), T (i.e., the replenishment cycle time), and $T+N$ (i.e., the time at which the retailer receives the payment from the last customer), we have the following three possible sub-cases: (i) $M \leqslant T$, (ii) $T \leqslant M \leqslant T+N$, and (iii) $T \leqslant T+N \leqslant M$. Now, let us discuss the detailed formulation in each sub-case.

Sub-case 1.1. $M \leqslant T$…

Optimal order quantity

Let us discuss the first case of $N \leqslant M$, and then the case of $N \geqslant M$. To minimize the annual total relevant cost, taking the first-order and the second-order derivatives of $TRC_1(T)$, $TRC_2(T)$, and $TRC_3(T)$ with respect to T, we obtain $\frac{dTRC_1(T)}{dT} = \frac{-1}{T^2}\left\{A + \frac{D[\alpha M^2 + (1-\alpha)(M-N)^2](cI_c - pI_e)}{2}\right\} + \frac{D(h+cI_c)}{2}$,
$\frac{d^2TRC_1(T)}{dT^2} = \frac{1}{T^3}\left\{2A + D[\alpha M^2 + (1-\alpha)(M-N)^2](cI_c - pI_e)\right\}$,
$\frac{dTRC_2(T)}{dT} = \frac{-1}{T^2}\left[A + \frac{D(1-\alpha)(M-N)^2(cI_c - pI_e)}{2}\right] + \frac{D[h+(1-\alpha)cI_c + \alpha pI_e]}{2}$,
$\frac{d^2TRC_2(T)}{dT^2} = \frac{1}{T^3}[2A + D(1-\alpha)(M-N)^2(cI_c - pI_e)]$, $\frac{dTRC_3(T)}{dT} = \frac{-A}{T^2} + \frac{D(h+pI_e)}{2}$, and
$\frac{d^2TRC_3(T)}{dT^2} = \frac{2A}{T^3} > 0$.

It is clear…

A numerical example

In order to illustrate the previous results, let us apply the theoretical results to solve the following real-world example.

Example 1

A one-dollar store (i.e., p=\$1) buys nail cutters from a supplier at c=\$0.50 a piece. The supplier offers a permissible delay if the payment is made within 60 days (i.e., M=2/12=1/6). This credit term in finance management is usually denoted as “net 60” (e.g., see Brigham, 1995). However, if the payment is not paid in full by the end of 60 days, then 8% interest (i.e., I_c…

…

Conclusions

In this paper, I have established an inventory lot-sizing model for a retailer who receives a full trade credit from its supplier, and offers either a partial trade credit to its bad credit customers or a full trade credit to its good credit customers. Then I have derived the theoretical results, and provided an easy-to-use closed-form optimal solution. Finally, I have used a real-world inventory problem to illustrate the proposed model and its optimal solution.

In this paper, we assume that the …

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