Optimal Ordering Strategy of a Replenishment Policy for Deteriorating Items Under Retailer’s Partial Trade Credit Policy

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ABSTRACT

This paper investigates the economic order quantity inventory model for a retailer under two levels of trade credit to reflect the supply chain management situation. It is assumed that the retailer maintains a powerful position and can obtain full trade credit offered by supplier, yet the retailer just offers the partial trade credit to customers. Under these conditions, the retailer can obtain the most benefits. This study also investigates the retailer’s inventory policy for deteriorating items in a supply chain management situation as a cost minimization problem. The present study shows that the annual total variable cost for the retailer is convex, that is, a unique solution exists. Mathematical theorems and algorithms are developed to efficiently determine the optimal inventory policy for the retailer. The results in this paper generalize some already published results. Finally, numerical examples are given to illustrate the theorems and obtain managerial phenomena.

Keywords: Deteriorating Items, EOQ Model, Inventory, Partial Trade Credit, Supply Chain, Two-Level Trade Credit

1. INTRODUCTION

Achieving effective coordination among suppliers and retailers has become a pertinent research issue in supply chain management. In real life business via share marketing, trade credit financing becomes a powerful tool to improve sales and profits in an industry. In today’s business transactions, it is more and more common to see that the supplier will allow a certain fixed time period for settling the amount that the supplier owes to retailer for the items supplied. We term this period as trade credit period. During the trade credit period the retailer can sell the goods and accumulate revenue on sales and earn interest on that revenue via share market investment or banking business. A higher interest is charged if the payment is
not settled at the end of the trade credit period. This brings some economic advantage to the retailers as they may earn some interest from the revenue realized during the period of trade credit. Teng (2002) illustrated two more benefits of trade credit policy: (1) it should attract new customers who consider it to be a type of price reduction; and (2) it should cause a reduction in sales outstanding, since some established customers will pay more promptly in order to take advantage of trade credit more frequently. However, the strategy of granting credit terms adds an additional dimension of default risk to the supplier (Teng, Chang, & Goyal, 2005).

Over the years, the extensive use of trade credit has been addressed. Goyal (1985) is the first person to consider the economic order quantity (EOQ) inventory model under the condition of trade credit. Chand and Ward (1987) analyzed Goyal’s problem under assumptions of the classical economic order quantity model, obtaining different results. Chung (1998) presented the DCF (discounted cash flow) approach for the analysis of the optimal inventory policy in the presence of trade credit. Later, Shinn et al. (1996) extended Goyal’s (1985) model and considered quantity discount for freight cost. Teng (2002) assumed that the selling price is not equal to the purchasing price to modify Goyal’s model (1985). Chung and Huang (2003) extended this problem within the economic production quantity (EPQ) framework and developed an efficient procedure to determine the retailer’s optimal ordering policy.

However, the perishability of goods is a realistic phenomenon. In real-life situations there are certain products like volatile liquids, medicines, food stuff, blood bank, materials, etc., in which the rate of deterioration due to vaporization, damage, spoilage, dryness etc. is very large. Therefore, the loss due to deterioration should not be ignored. Aggarwal and Jaggi (1995) developed inventory model with an exponential deterioration rate under the condition of permissible delay in payments. Chu et al. (1998) extended Goyal’s model to the case of deterioration. Jamal et al. (1997), Chang and Dye (2001) further generalized the model with shortages. Shah and Shah (1998) developed a probabilistic inventory model when delay in payment is permissible. They developed an EOQ model for deteriorating items in which time and deterioration of units are treated as continuous variables and demand is a random variable. Chung and Liao (2006) dealt with the problem of determining the EOQ for exponentially deteriorating items under permissible delay in payments depending on the ordering quantity. Mahata and Goswami (2006) presented a fuzzy EPQ model for deteriorating items when delay in payment is permissible. Many related articles can be found in Hwang and Shinn (1997), Jamal et al. (2000), Arcelus et al. (2003), Abad and Jaggi (2003), Chang (2004), Chung et al. (2005), Teng et al. (2005), Chung and Liao (2006) and their references.

All the above articles assumed that the supplier would offer the retailer a delay period and the retailer could sell the goods and accumulate revenue and earn interest within the trade credit period. They implicitly assumed that the customer would pay for the items as soon as the items are received from the retailer. That is, they assumed that the supplier would offer the retailer a delay period but the retailer would not offer any delay period to his/her customer. That is one level of trade credit. In most business transactions, this assumption is unrealistic. Usually the supplier offers a credit period to the retailer and the retailer, in turn, passes on this credit period to his/her customers. For example, in India, the TATA Company can delay the amount of purchasing cost until the end of the delay period offered by his supplier. The TATA Company also offers permissible delay payment period to his dealership. Recently, researchers developed inventory models under this two level trade credit financing. Huang (2003) presented an inventory model assuming that the retailer also offers a credit period to his/her customer which is shorter than the credit period offered by the supplier, in order to stimulate the demand. Huang (2006) extended Huang’s (2003) model to investigate the retailer’s inventory policy under two levels of trade credit and limited storage space. Huang (2007) incorporated Huang (2003)
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