Chapter 2

Optimal Policies for Items With Quadratic Demand and Time-Dependent Deterioration Under Two Echelon Trade Credits

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ABSTRACT

In today’s competitive and global business scenario there is always a race to boost demand of your product over others. This can be achieved by different means and allowing permissible delay in payments is one of them. Researchers have proposed number of inventory models with trade credit that actually help to understand effect of trade credit on total profit and overall demand. This paper proposes a two – echelon trade credit where retailer receives credit period from the manufacturer and offer it to end customers appropriately to raise demand. Proposed inventory model assumes quadratic demand and subjected to time dependent deterioration. Ordering cost is considered lot – size dependent whereas holding cost has been taken time dependent. In this model profit is maximized considering cycle time as a decision variable. Sensitivity analysis of crucial inventory parameters and numeric examples are discussed in detail. Outcome of this model can be applied to a huge range of products like readymade garments, fashion accessories, electronics, furniture and home furnishing products.

INTRODUCTION

Offering credit to buyers is actually not new it is being practiced since a long time to accelerate demand positively. During this credit period, the retailer can sell the items and generate revenue, using this revenue retailer earns interest by depositing it in some interest bearing account or in some financial terms. Haley & Higgins (1973) proposed credit policy for classical EOQ and further explored its effect on

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inventory policy. Chapman et al. (1984) derived an EOQ model that allows payment delays to boost demand. Goyal (1985) discussed a lot size model with permissible delay that charge interest on the amount remain outstanding after the permissible period. Shah et al. (1988) extended Goyal’s paper by including shortages in the model. Mandal & Phaujdar (1989 a, 1989b) further extended Goyal’s paper by adding interest earned on sales revenue. Khouja & Mehrez (1996) developed vendor credit policy to determine optimum lot size policy when credit is lot size dependent. Huang (2003) established that the retailer gets benefited if the credit period which is received from the supplier is passed onto the customers. The economic order quantity is computed when the supplier offers the retailer a credit period $M$ and the retailer passes a credit period $N$ to the customers with $N < M$. This scenario is known as two-level trade credit. Teng and Chang (2009) analyzed the two-level trade credit by relaxing the assumption $N < M$. Chang et al. (2003, 2009) further developed inventory model with the effect of deterioration. Khanra et al. (2003) worked on the same line with the assumptions of time dependent quadratic demand. Later on, Chung & Liao (2004, 2006), Chung et al. (2005), Dye and Ouyang (2005) studied different ordering policy where trade credit remains lot size dependent. Shah et al. (2010) gave a complete review of trade credit in inventory system. Shah & Shukla (2010, 2011) studied the effect of trade credit in the scenario of decreasing demand due to inflation. Sarkar (2012) offered delay in payments for deteriorating inventory model. Sarkar & Sarkar (2013) developed better model for time – dependent deteriorating inventory when demand is stock dependent. Shah et al. (2014) presented a model for deteriorating items with fixed lifetime. Shah et al. (2014) also discussed order quantity linked credit policy to optimize joint profit of supplier and retailer.

Most of the researchers formulated and discussed inventory models with constant, linear or exponential time dependent demand. This paper assumes quadratic demand with time dependent deterioration. Ordering cost is generally assumed constant but since practically it is always lot size dependent it is assumed so in this paper. Many studies related to supply chain profit maximization suggests that trade credit offered at each level of supply chain accelerates demand positively. So in this proposed model credit received by retailer from manufacturer is appropriately forwarded to end customers to boost demand. Items in the inventory are subjected to time dependent deterioration that precisely follows two parameter weibull distribution. Most of the above mentioned paper uses holding cost constant but to make model more practical here it is being assumed time dependent. This paper optimizes total profit of retailer by optimizing decision variables cycle time and optimum lot size.

**NOTATION AND ASSUMPTIONS**

The proposed model has the following notation and assumptions.

**Notation**

$D(t)$: Demand rate, $\left[ a \left( 1 + bt - ct^2 \right) \right]$ where $a > 0$ denotes scale demand, $b > 0$, $c < 1$ denotes rate of change of demand. Also, $(1 + bt - ct^2) > 0$

$A_r$: Ordering cost $A \left( 1 + lQ \right)$

$C$: Purchase cost per unit
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