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Optimal pricing, shipment and payment policy for an integrated supplier–buyer inventory model with two-part trade credit

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Abstract

In this article, we develop an integrated supplier–buyer inventory model with the assumption that the market demand is sensitive to the retail price and the supplier adopts a trade credit policy. The trade credit policy discussed in this paper is a "two-part" strategy: cash discount and delayed payment. That is, if the buyer pays within M_1, the buyer receives a cash discount; otherwise, the full purchasing price must be paid before M_2, where $M_2 > M_1 \geqslant 0$. The objective of this research is to determine the optimal pricing, ordering, shipping, and payment policy to maximize the joint expected total profit per unit time. An iterative algorithm is established to obtain the optimal strategy. Furthermore, numerical examples and sensitivity analysis are presented to illustrate the results of the proposed model and to draw managerial insights.

Keywords: Integrated inventory model; Delay payment; Cash discount; Demand function

1. Introduction

The traditional economic order quantity (EOQ) model assumes that the buyer must pay off as soon as the items are received. In fact, allowing customers to delay payment for goods already delivered is a very common business practice. Suppliers often offer trade credit as a marketing strategy to increase sales and reduce on-hand stock level. Once a trade credit has been offered, the amount of time that the buyer's capital tied up in stock is reduced, and that leads to a reduction in the buyer's holding cost of finance. In addition, during the time of the credit period, buyers may earn interest on the money. In fact, buyers, especially small businesses which tend to have a limited number of financing opportunities, rely on trade credit as a source of short-term funds. Goyal (1985) was the first to establish an economic order quantity model with a constant demand rate under the condition of permissible delay in payments. After that, numerous studies dealing with

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the trade credit problem have been presented. For example, Aggarwal and Jaggi (1995), Kim et al. (1995), Jamal et al. (1997), Shinn (1997), Chu et al. (1998), Chen and Chuang (1999), Chang and Dye (2001), Teng (2002), Chung and Huang (2003), Shinn and Hwang (2003), Chung and Liao (2004, 2006), Chung et al. (2005), Teng et al. (2005), Ouyang et al. (2005), and so on.

The above papers assume that the supplier offers the buyer a "one-part" trade credit, i.e., the supplier offers a specified period without interest charge to the buyer that is to be paid off within a permissible delay period. As a result, with no incentive for making early payments, and earning interest through the accumulated revenue received during the credit period, the buyer postpones payment up to the last moment of the permissible period allowed by the supplier. Therefore, from the supplier's perspective, offering trade credit leads to delayed cash inflow and increases the risk of cash flow shortage and bad debt. To accelerate cash inflow and reduce the risk of a cash crisis and bad debt, the supplier may provide a cash discount to encourage the buyer to pay for goods quickly. In other words, the supplier offers a "two-part" trade credit to the buyer to balance the trade-off between delayed payment and cash discount. For example, under a contract, the supplier agrees to a 2% discount deducted from the buyer's purchasing price if payment is made within 10 days. Otherwise, full payment is required within 30 days after the delivery. This credit term in financial management is denoted as "2/10 net 30". If the supplier only offers the buyer a 30 days delay payment, i.e., "one-part" trade credit, then this credit term is denoted as "net 30" (Brigham, 1995, p. 741). There are more papers related to this trade credit policy such as Lieber and Orgler (1975), Hill and Riener (1979), Kim and Chung (1990), Arcelus and Srinivasan (1993). Recently, Ouyang et al. (2002), Chang (2002) and Huang and Chung (2003) developed inventory models in which the supplier provides a permissible delay and a cash discount for early payment.

However, the previous inventory models on trade credit focused only on the supplier's or buyer's performance. They ignored the fact that each parties' local objectives may often conflict. Lee et al. (1997) pointed out that without coordinated inventory management throughout the supply chain results in excessive inventory investment, revenue reduction and delays in response to customer requirements. Therefore, determining the optimal policies based on the maximum/minimum integrated total profit/cost is more reasonable than considering the buyer's or the supplier's individual profit/cost. Goyal (1976) first developed a single supplier–single customer integrated inventory model. Subsequently, Banerjee (1986) extended Goyal's (1976) model and assumed that the supplier followed a lot-for-lot shipment policy with respect to a buyer. Later, Goyal (1988) illustrated that the inventory cost can be reduced if the supplier's economic production quantity is an integer multiple of the buyer's purchase quantity. Lu (1995) then generalized Goyal's (1988) model by relaxing the assumption that the supplier can supply to the buyer only after completing the entire lot size. Many researchers (e.g. Bhatnagar et al., 1993; Goyal, 1995; Viswanathan, 1998; Hill, 1997, 1999; Kim and Ha, 2003; Kelle et al., 2003; Li and Liu, 2006) continued to propose more batching and shipping policies for an integrated inventory model. These studies on integrated inventory problems did not take the effect of trade credit on the optimal policy between the supplier and buyer into account. Abad and Jaggi (2003) first offered a supplier–buyer integrated model following a lot-for-lot shipment policy under a permissible delay in payment. In Abad and Jaggi's model (2003), the supplier offered a "one-part" trade credit to the buyer.

In light of the lack of research dealing with the operational impact of a "two-part" trade credit policy in the integrated inventory model, we develop an integrated inventory model with a retail price sensitive demand. We assume that the supplier offers the buyer a cash discount if payment is made before a specified period, and if the buyer does not pay within the specified period, the full purchasing price must be paid before the delay payment due date. The goal of this research is to determine the optimal payment policy, retail price, lot size, and number of shipments from supplier to buyer in one production run in order to maximize the joint expected total profit. An algorithm is designed to determine the optimal policy. Numerical examples are presented to illustrate the theoretical results. Furthermore, the sensitivity of the optimal solutions with respect to some parameters is also examined.

2. Assumptions and notation

The following assumptions and notation were made in developing the proposed model:

1. There is a single supplier and a single buyer for a single product in this model.
2. Shortages are not allowed.