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Inventory management in supply chains: A bargaining problem

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Abstract

This paper is focused on supply chain management from the perspective of inventory management. The coordination of order and production policies between buyers and suppliers in supply chains is of particular interest. When a buyer of an item decides independently, he will place orders based on his economic order quantity (EOQ). However, the buyer's EOQ may not lead to a favorable policy for the supplier. A cooperative order and production policy can reduce total cost significantly. Should the buyer have the dominant position to impose his EOQ on the supplier, then consequently no incentive exists for him to deviate from his EOQ in order to choose a cooperative policy. To induce the buyer to order in quantities more favorable to the supplier, the supplier could offer a cooperative policy associated by a side payment to the buyer. The research presented in this paper provides several bargaining models depending on alternative production policies of the supplier. With these bargaining models the offered cooperative policy and the offered side payment can be derived.

Keywords: Inventory management; Joint economic lot size; Buyer–supplier relationships; Bargaining problem

1. Introduction

1.1. The problem of coordination: EOQ and ELS solutions

The term supply chain management refers to cooperative management of materials and information flows between supply chain partners, to reach goals that cannot be achieved acting individually. This paper focuses on the supply chain from the perspective of inventory management.

In contrast to multi-echelon inventory management, that coordinates inventories at multiple locations of one company, a joint inventory replenishment policy in supply chains involves coordination among multiple firms (Johnson and Pyke, 2001, pp. 794–795). Therefore, the coordination of order policy and production policy between

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buyers and suppliers in supply chains is of special interest (Landeros and Lyth, 1989, pp. 146–147). When the buyer and supplier treat inventory problems singly under deterministic conditions, the economic order quantity (EOQ) formula or the economic lot size (ELS) formula gives an optimal solution. However, in general, an order policy based on the EOQ solution is undesirable to the supplier and likewise, a production and delivery policy based on the ELS solution is unacceptable to the buyer (Lu, 1995, p. 312).

1.2. JELS models with equal and unequal sub-batches

The problem of coordination between the order policy and the production policy of a buyer and a supplier has received considerable attention in recent years. Goyal (2000), Goyal and Gupta (1989), Joglekar and Tharthare (1990), Thomas and Griffin (1996), and Sharafali and Co (2000) give detailed reviews of integrated buyer–supplier inventory models. A number of authors, including Goyal (1976, 1988), Banerjee (1986b), Landeros and Lyth (1989), Chatterjee and Ravi (1991) and Agrawal and Raju (1996) demonstrate methods to gain cost savings. They suggest joint economic lot size (JELS) models where the objective is to minimize the joint total relevant costs for both the buyer and the supplier. It is shown that an integrated inventory replenishment policy is more desirable than individual optimal policies of the parties involved. While all models use the accepted EOQ formula to determine buyer's individual optimal order policy, the distinguishing feature is the assumed production and delivery policy of the supplier. Goyal (1976) assumes an infinite production rate for the supplier. Banerjee (1986a) generalizes Goyal's model by integrating a finite production rate, assuming that the supplier follows a lot-for-lot policy. Goyal (1988) further relaxes the lot-for-lot assumption by assuming that each production batch is dispatched to the buyer in an integer number of equal sized sub-batches. Landeros and Lyth (1989) further generalize these models by incorporating fixed delivery cost associated with each shipment to the buyer. However, these models assume that the whole production batch must be finished before any shipments from the batch can take place. Agrawal and Raju (1996) consider that the supplier may wish to ship a number of equal sized sub-batches before the whole production batch is finished. Based on a much earlier idea set out by Goyal (1977), Goyal (1995) shows the use of unequal sized sub-batches. This production and delivery policy involves successive shipments within a production batch so that the size of the sub-batches increases according to a geometric series. The *i*th sub-batch size within a production batch will be: (first shipment size) $\cdot$ (production rate/demand rate)$^{(i-1)}$. Chatterjee and Ravi (1991) present an equivalent model considering fixed delivery costs associated with each shipment. Viswanathan (1998) shows that neither a policy with equal sized sub-batches nor a policy with unequal sized sub-batches dominates the other. Hill (1997), however, suggests a more general class of supplier's production and delivery policies. The *i*th sub-batch size is given by: (first shipment size)$y^{(i-1)}$, with $1 \leqslant y \leqslant$ (production rate/demand rate). He shows that, at a fixed transportation cost per shipment, the total costs are smaller then using equal sized sub-batches. Another kind of delivery policy is shown in Goyal and Szendrovits (1986), Goyal and Nebebe (2000) and Goyal (2000). A certain number of unequal-sized sub-batches are combined with a number of equal sized sub-batches. However, one may identify two deficiencies of delivery policies with unequal sized sub-batches. First, the capacity of the handling, packing and shipping equipment must be at least equal to the largest sub-batch size and hence, becomes underutilized for smaller sub-batch sizes, which leads to idle-capacity costs (Goyal and Szendrovits, 1986, p. 204). On the other hand, if the size of a sub-batch exceeds the load-capacity of the transportation unit more then one shipment per sub-batch are necessary. Therefore, using unequal sized sub-batches, it is inappropriate to treat shipment costs as being independent of the sub-batch size (Szendrovits, 1978, p. 1018). Second, supply and receipt of unequal sized sub-batches associated with order intervals of different length cause a prohibitive operational planning and control effort for the supplier and the buyer (Agrawal and Raju,