

Coordinating pricing and inventory replenishment policies for one wholesaler and one or more geographically dispersed retailers[☆]

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Abstract

We analyze coordination issues in a supply chain consisting of one wholesaler and one or more retailers under deterministic price-sensitive customer demand. Operating costs include purchasing, setup, order processing, and inventory costs. We consider both pricing and lot sizing decisions and take special care to correctly account for the impact of transfer prices and ownership of retail-inventory. We show that a solution that maximizes channel profits can be interpreted as consignment selling. We also show that separating pricing and lot sizing decisions is near optimal when the demand rate is sufficiently large. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction and motivation

The central theme of multi-echelon inventory has been the coordination of lot sizing decisions among vertically integrated firms. Modern supply chain management can derive important insights by revisiting multi-echelon inventory models in the context of non-vertically integrated firms where pricing decisions, in addition to lot sizing decisions, need to be coordinated.

There is ample empirical evidence on the growing trend in practice towards integrated

supply chain management. For example, a recent survey by Deloitte Consulting [1] concludes that “extending the supply chain is number one priority” for more than 200 large manufacturers and distributors in the United States and Canada, representing a wide cross section of industries including aerospace, automotive, consumer products, high-tech, among others. Fortunately, advances in information technology enable firms to rapidly exchange products, information and funds, and utilize collaborative methods to optimize supply chain operations. As a result, supply chain members are moving away from traditional arms’ length relationships, and are forming creative “partnerships” (e.g. consignment selling, vendor managed inventory) that are based on information exchange and a team approach of

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making channel decisions (see Handfield and Nichols [2] and Kumar [3] for example).

In this paper we first study a supply chain consisting of a single wholesaler, a single retailer, and a group of consumers whose collective demand is decreasing in price. We focus on inventory and pricing policies that *jointly* maximize channel (wholesale plus retail) profits (net revenues minus inventory related costs). In doing so, we account for the impact of retail inventory ownership on channel holding costs, which is characterized by the timing of transfer payments from the retailer to the wholesaler. We find that earlier conclusions about the desirability of wholesaler-led or jointly negotiated quantity discount policies depend crucially on the implicit assumption of retailer owned inventory. We find that an optimal coordinated policy can be implemented as a nested replenishment policy where the retailer pays the wholesaler the unit wholesale price as the items are sold, and the retail price is set jointly. By adjusting the wholesale price, this inventory-consignment policy is also capable of distributing the gains of channel coordination without requiring side-payments. We also explore the suboptimality induced (in channel profits) by first making retail pricing decisions (ignoring inventory related costs) and then making inventory replenishment decisions for the resulting prices. We show that this practice of separating pricing and lot sizing decisions is near optimal for inventory systems with high demand rates. This “separation theorem” vindicates the current practice of separating marketing (pricing) and operational (lot sizing) decisions, and indicates that opportunities to improve profits by coordinating these decisions are limited to systems with relatively low demand rates. Finally, we extend most of our results to the case of multiple geographically dispersed retailers.

This paper is organized as follows. In Section 2 we provide an overview of the existing literature. In Section 3, we develop our model and explore the impact of the ownership of the retail inventory. In Section 4 we analyze total channel profit function and discuss various methods to implement the optimal policy. Section 5 discusses the extension of our model to the multiple retailers. Section 6 contains our concluding remarks.

2. Literature review

There exists a substantial literature analyzing various aspects of wholesaler–retailer coordination. Here we provide a review of the literature on channel coordination under deterministic demands, which is most relevant to the problem considered in this paper. One stream of earlier research in this area follows what we call the Marketing Approach (MA). Researchers following the MA model final demand as a decreasing function of retail price and assume constant marginal operating cost for the channel without specifically incorporating inventory replenishment decisions and costs. The MA literature focuses on the problem of double marginalization (markup both at the wholesale and retail level), which is a consequence of decentralized decision making in the channel. To avoid double marginalization and to maximize channel profits, jointly negotiated or wholesaler led quantity discounts¹ are proposed. Use of such quantity discounts in channel coordination first appears in Jeuland and Shugan [4] in their analysis of a two member channel, and later in Moorthy [5], and is more recently extended by Ingene and Parry [6] to multiple independent retailers.

The other stream of research follows what we call the Operations Approach (OA). Researchers following the OA model the operating costs for the channel as a function of the retailer’s order quantity (lot size), while assuming a fixed retail price (and hence a fixed final demand). Exceptions to the latter assumption are Parlar and Wang [7] and Weng [8] who assume that customer demand is decreasing in retail price. The OA assumes that the wholesaler is in the leader position, maximizing his profit by inducing the retailer, through a quantity discount scheme, to place larger orders. Within the OA research stream, models differ significantly in the method used to incorporate the impact of a retailer’s order quantity on the wholesaler’s holding cost. This results in the study

¹These quantity discount schemes are in fact “volume discounts”, since the qualifying units for the discounts are not the quantity per order but rather the total order quantity per year.

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