Coordinating supply chains with sales rebate contracts and vendor-managed inventory

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A R T I C L E   I N F O

A B S T R A C T

Coordinating supply chains is an effective way to improve channel performance. This paper details how a sales rebate contract helps achieve supply chain coordination which allows decentralized decisions of chain members to perform a centralized decision for the whole system. A model in the context of a two-echelon supply chain with a single supplier serving multiple retailers in vendor-managed inventory (VMI) partnership is proposed. VMI facilitates the application of the sales rebate contract since information sharing in VMI partnership allows the supplier to obtain actual sales data in a timely manner and determine the rebate for retailers. Retailers are considered in two scenarios: independent retailers with a demand function sensitive only to their own price and competing retailers with a demand function depending on all retailers' prices. The proposed model demonstrates that the supplier gains more profit with competing retailers than without as competition among the retailers lowers the prices and thus stimulates demand.

1. Introduction

In today's global market, more and more companies realize that the performance of their businesses depends largely on external collaboration and coordination across the supply chain. As chain members are primarily concerned about their individual interests which may not contribute to the overall supply chain performance, their decisions may result in an inefficient network system with problems like high costs, compromised customer service and a weakened strategic position (Fugate et al., 2005).

Much research focuses on coordination schemes achieving supply chain coordination, particularly the type of contractual arrangement that is required for coordination (Cachon, 2003). The sales rebate contract is one of the contracts that coordinate the supply chain with one compliance regime, and channel rebates are widely adopted in the hardware, software and auto industries (Taylor, 2002). A rebate is different from an order quantity discount as it only applies to items sold to end-users. Hence, a rebate contract is more efficient than an order quantity discount because it provides a direct incentive for retailers to increase sales.

However, it is difficult to implement a sales rebate contract in a traditional supply chain, mainly because a traditional supply chain does not have a mechanism to facilitate continuous information exchange between chain members. The supplier needs to know the exact quantity sold by the retailer in order to pay the rebate but difficulties arise when the supplier cannot acquire the retailer's sales data directly. On the other hand, the data obtained from the retailer may not be authentic as the retailer may claim more rebates than what the actual sales allow. Difficult administration is probably the reason for a preference for an order quantity discount over a sales rebate, despite the fact that a sales rebate is a better sales incentive.

When the vendor-managed inventory (VMI) partnership was proposed and put into practice, the situation has since been changed. The supplier monitors the retailer's

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inventory levels (physically or via electronic messaging) and makes periodic replenishment decisions in terms of quantity and frequency. As the sales quantity is made known to the supplier, it provides a basic condition for feasibility of a sales rebate. The supplier can obtain more information for analysis, such as customer preferences and sales performance influenced by the retail prices through electronic data interchange (EDI) and points of sales (POS). VMI partnership thus facilitates the implementation of the sales rebate contract.

In this study, the sales rebate contract in VMI partnership is examined to see how it achieves supply chain coordination so that each member's decisions is aligned with the global supply chain's objectives. A two-echelon supply chain composed of a single supplier and multiple retailers is also examined. In VMI partnership, the supplier adopts a periodic review policy to replenish inventory for each retailer. The supplier first determines a base-stock level for each retailer conditioned by the customer service level (CSL), and then in every replenishment period increases the retailers' inventory up to the base-stock level. Each retailer faces a comparatively stationary stochastic demand as the demand distribution is almost identical in every period.

The rebate contract has the effect of motivating retailers to lower prices for increasing sales, so it is a good application for system coordination. Taylor (2002) discussed a rebate contract which coordinated a supply chain composed of one supplier and one retailer, in which retailers were allowed to determine their order quantities consistent with the optimal order quantities so as to optimize the global supply chain's profit. Different from Taylor's work, our study addresses a VMI system in which retailers are not concerned about order decisions but only price choices, and therefore how to coordinate retailers' price decisions with the global supply chain objective is the main concern. In addition, two different scenarios are addressed in this study: an independent retailer with a demand function only sensitive to individual prices, and competing retailers with a demand function depending on other retailers' prices. The coordinated results are compared in the two scenarios, and the impact of the competition on coordination is investigated.

The main contribution of this study is to propose a coordination scheme for VMI partnership through the sales rebate contract. VMI partnership facilitates the application of the rebate contract because information sharing in VMI partnership allows the supplier to gain actual sales data, which is a necessary condition for implementing the sale rebate contract. The idea of how the sales rebate contract in VMI partnership influences decentralized supply chain coordination has rarely been mentioned in the related literature, especially the insight into the influence of competition among heterogeneous retailers on the chain coordination.

The remainder of this paper is organized as follows. The next section reviews the related literature. Section 3 defines the notation used and specifies the proposed model. Section 4 studies the model with independent retailers and presents the impact of the sales rebate contract on supply chain coordination. Section 5 addresses the case of competing retailers and the impact on chain coordination. The final section discusses the results and a conclusion is made.

2. Literature review

With the development of information technology, information sharing restructures the supply chain by coordinating decision-making and integrating supply chain activities. There have been various studies on supply chain coordination and there is still a growing interest in it.

Whang (1995) classified the coordination from an organizational perspective in terms of single-person, team-based and nexus-of-contract approaches. Sahin and Robinson (2002) proposed price, non-price, buy-back and return policies, quantity flexibility, allocation rules, information sharing and flow coordination as major categories of coordination mechanisms. Fugate et al. (2005) modified the formal classification and turned it into three categories, namely, price, non-price and flow coordination mechanisms. The classification can therefore be summarized as flow coordination and contract-based coordination.

Flow coordination mechanisms are designed to manage product and information flows in a supply chain. As a supply chain involves flows of financial, information and product/service, effective and efficient management of flows is essential to improve the supply chain performance. Various flow coordination schemes based on information sharing have been studied and applied, such as VMI, quick response (QR), Collaborative planning, forecasting and replenishment (CPFR), efficient consumer response (ECR), and postponement (Kulp et al., 2004; Angulo et al., 2004; Lowson et al., 1999; Hunter et al., 2002; Frohlich, 2002; Esper and Williams, 2003; Chiou et al., 2002). Also, the effort of using information sharing and flow coordination to eliminate the "bullwhip effect" was investigated (Sahin and Robinson, 2002; Disney and Towill, 2003; Moyaux et al., 2006).

VMI is an important flow coordination scheme which integrates operations between suppliers and retailers through information sharing and business process reengineering. Its benefits to supply chain management have been well documented (Waller et al., 1999; Disney and Towill, 2003). Buzzell and Ortmeyer (1995) reported that the implementation of VMI partnership at Dillard Department Stores, JCPenny, and Wal-Mart increased the sales performance by 20–25% and improved the inventory turn by 30%. The extensive studies found in the VMI literature mostly focus on finding a flexible strategy for replenishment, shipments coordination, balancing production within capacity limitations, and the impact of information sharing on performance. Clark and Hammond (1997) analyzed the inventory turns and stockout levels of 26 retailers who worked with Campbell Soup Company and found a dramatic improvement in inventory turns when EDI was coupled with VMI via four case studies. Cetinkaya and Lee (2000) presented an analytical model of stock replenishment and shipment scheduling for VMI