

Multi-Period Coordination Mechanism Based on Revenue Sharing Contract in VMI Model

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Abstract. Vendor Managed Inventory (VMI) model coordinates the supply chain, for the vendor is authorized to manage retailer's inventory and revenue-sharing contract helps to achieve the coordination. In this paper, a multi-period two-echelon supply chain coordination model, which is composed of a manufacturer and a retailer, is built. Under the assumption that the market demand rate is affected by time, sales price and the current inventory level, the supply chain profit models of centralized decision and decentralized decision based on VMI model are established respectively, with optimal decisions obtained in each model. Furthermore, the revenue sharing contract is used to synchronize the supply chain in the VMI model and in turn the analytical model in the supply chain to achieve Pareto improvement is obtained. An equation describing thin film oscillating is used to correct the profit value in VMI model to simulate the reality. Finally, a numerical illustration validating the model and analytical results showing parameters' varying effects on the profit and optimal quantity of each party, are presented. The results demonstrate that the revenue sharing contract is able to simultaneously improve the interests of parties in the multi-period VMI supply chain.

AMS subject classifications: 34D10, 34D20

Key words: Multi-period, supply chain, VMI, revenue sharing contract, Fourier transform.

1 Introduction

With the development of the competitive environment and management method change, the business battlefield shifts from enterprise singles to supply chains. Enterprises must not only make full use of their own resources, but also cooperate with upstream and downstream enterprises in supply chain to integrate information and resources to gain

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competitive advantages. Therefore, the coordination of supply chain is particularly of importance [1], in which the manufacturer and retailer no longer trade once but form a long-term contract partnership [2], so there must be a multi-period ordering relationship within the supply chain. Although the single period supply chain has been well studied in current researches, most studies optimized the supply chain on a single period [3–6]. From a multi-period perspective, it achieves a local optimum but not necessarily the global optimal [7]. Therefore, multi-period supply chain is of great research value.

Vendor Managed Inventory (VMI), which is based on the whole management process of product information, is derived from the idea of supply chain management based on the premise that the supplier and the retailer receive the lowest costs at the same time. The inventory management under the supplier minimizes the whole inventory costs and increases the distributable profit across the supply chain. Compared with the traditional Retailer Managed Inventory (RMI) mode, the VMI mode promotes information sharing, reduces the "bullwhip effect" caused by the distortion of demand information and improves the supply chain collaboration level [8–10], making the supply chain to adjust itself to the market, helping to change the phenomenon of serious overproduction and inventory backlog, hence achieving the full use of resources conditionally. The quality of different models depends on the subjective decision-making behaviors on both sides of the supply chain [11]. When manufacturers and retailers jointly take appropriate decision-making behaviors, the benefits of the VMI model can be realized.

In the actual sales process, the demand is influenced by many factors. Some scholars believe that the market demand rate is affected by the dual factors of sales price and time or current inventory level [12–15], but Bo [18] and others believe that the demand rate is affected by three factors of the sales price, current inventory level and time. They assume the quantity of market demand rate equals the reduction rate of retailers' inventory and the demand rate follows the equation $\frac{dI_1(t)}{dt} = -D(p, t, I_1(t))$.

This equation can be reasonable, as can be seen in normal life, in the sales process of products, displaying more products is conducive to generating more demand (Wal Mart) and setting a lower-level price is also an essential factor in demand ascending, according to the relationship between the supply and demand from economists. In addition, as for deteriorate goods or services combined with special provided goods with time limited (food, storage capability etc.), customers care about the production date, so time is also an important factor that affects the demand rate. In order to match the model to reality, this paper assumes that the market demand rate is affected by three factors: sales price, time and current inventory level and modifies the model from Bo.

However, although VMI improves the overall benefit of the supply chain, it does not remove the negative impact of bilateral effects on supply chain management [16]. In order to simulate the bullwhip effect in reality, two parts are added into the model, sharing contract mechanism, to stimulate the parties and a nonlinear profit fixed equation to simulate other parameters which are not discussed in this paper. Supply chain contracts are the primary methods to realize supply chain coordination including revenue sharing contract, option contract, repurchase contract, quantity discount contract, etc. Ratio-