Optimal Pricing and Replenishment for Deteriorating Items in B2B Electronic Markets

Liang-Tu Chen* and Chun-Yi Yeh

Graduate Institute of E-Business National Pingtung Institute of Commerce
51, Minsheng E. Rd, Pingtung 900, Taiwan
ltchen@npic.edu.tw

Abstract. The study proposes the inter-enterprise optimal dynamic decisions: retail price and replenishment scheduling/quantity under the retailer-managed inventory with price-only contract and the vendor-managed inventory (VMI) with consignment contract in electronic markets (EMs) respectively for deteriorating items. The numerical analysis shows that the proposed policy under the VMI with consignment can significantly increase the system efficiency and simultaneously achieve the Pareto improvements using slotting allowances for the decentralized channel in the EMs.

Keywords: Inter-enterprise, Electronic markets, Deteriorating item.

1 Introduction

In recent years, electronically-enabled supply chains have offered the potential for improving supply chain performance, including increasing coordination effectiveness and transaction efficiency, by changing the quantity and the velocity of information flow among channel partners [1]. Heinrich and Simchi-Levi [2] mentioned that there is a substantial link between information technology (IT) strategy, business processes, and supply chain performance according to a study by MIT, PERM and SAP. Numerous evidences show that enterprises applying business processes and IT systems outperform their competitors [3]. In practice, electronic markets (EMs) are an increasingly important research topic on the IT domain [4]. As advances in technology, internet-based EMs through low transaction cost and easy searching for buyers and sellers change the trade way in a channel from traditional markets into the EMs. In addition to increasing operational efficiency, the highly integrated system can strengthen strategic advantages and generate related benefits that have been well documented in the literature [4, 5]. An important building block in effective supply chain strategies is strategic partnerships between suppliers and buyers. The benefits of inter-organizational cooperation between upstream and downstream entities in a supply chain include cutting costs, enhancing profits, and other tangible and intangible rewards [6].

* Corresponding author.
One of the primary coordinating mechanisms is to streamline the business flows of goods and information and the decision-making processes among channel partners using vendor-managed inventory (VMI) for a vertically decentralized channel. The strategic partnerships change the ways to share information and manage inventory in a supply chain, possibly eliminating the impact of bullwhip effect [3]. Numerous channel partners engaging in collaboration and information sharing in supply chain management (SCM) via the VMI system allow vendors to harness latest retailer sales data to better forecast demand, reduce inventory and increase profit. For example, Buzzell and Ortmeyer [7] reported that these VMI projects at Dillard Department Stores, J.C. Penney and Wal-Mart have achieved sales increases of 20 to 25% and improvements in inventory turnover of 30%. However, the lately evolved enterprise resource planning systems can optimize the lot-size scheduling problem with time-varying demand over finite planning horizon, yet the dynamic aspects of pricing and other marketing related variables tend to be ignored in the highly computerized control systems. As a result, the system generates suboptimal solutions to the lot-size scheduling problem. This study uses calculus-based formulation coupled with DP techniques to solve optimal joint retail price and replenishment quantity/scheduling decision problem taking into account the dynamic nature of customer demand which is partially controllable through pricing scheme in a single-retailer and single-manufacturer channel over a multi-period planning horizon. Furthermore, the study proposes the two policies: the retailer-managed inventory with price-only (RMI with PO) and the VMI with consignment (VMI with consignment) in EMs respectively, while the channel sells a perishable product with multivariate demand function.

2 Problem Description

This study considers a single perishable item whose retail price and replenishment scheduling/quantity are reviewed periodically at time \( t, t = 0, 1, 2, \ldots, H \), where \( H \) is the planning horizon. Each period begins with a joint decision regarding the scheduling of a new replenishment and its associated retail price. The problem is equivalent to determining the optimal sequence of issuance times for new replenishment \( z_{i-1}, i = 1, 2, \ldots, n \), with the retail price being reset, and the lot-size simultaneously specified so as to maximize the profit stream over \([0, H]\). In the profit maximization problem, all the future revenue and costs are subject to the effects of inflation and time discounting. The net discount rate of inflation is assumed to be constant over time: \( R = r - i \), where \( i \) is the inflation rate and \( r \) is the discount rate representing the time value of money.

3 The Model

Traditionally, a usual behavior for vertically decentralized channel coordination is the RMI system with PO contract, where the retailer is entirely responsible for replenishment scheduling/quantity and retail price decisions. Recently, the other substitute for channel coordination is the VMI system with consignment contract, where the manufacturer is fully responsible for the replenishment scheduling/quantity