

Effects of inventory policy on supply chain performance: A simulation study of critical decision parameters

R.S.M. Lau^{a,*}, Jinxing Xie^{b,1}, Xiande Zhao^{c,2}

^a *Department of Information and Systems Management, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong*

^b *Department of Mathematical Sciences, Tsinghua University, Beijing 100084, China*

^c *Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong*

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Abstract

This paper investigates the effects of information sharing and early order commitment on the performance of four inventory policies used by retailers in a supply chain of one capacitated supplier and four retailers. Model parameters and operating conditions are emulated from a local business supplying a standard product to its retailers. Through computer simulation and subsequent analyses, we found that the inventory policy used by the retailers, information sharing, and early order commitment can significantly influence the performance of the supply chain. Out of the four inventory policies examined, the economic order quantity rule is found to be the best for the retailers and the entire supply chain, but periodic order quantity and Silver–Meal provide the best performance for the supplier. The sharing of future order plans by the retailer and the supplier is also shown to be the most effective way for reducing the supplier's cost and improving its service level; however, the magnitude of these benefits achieved is less for the retailers. In addition, early order commitment by the retailers is found to be beneficial to the supplier and retailers in reducing their total cost.

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1. Introduction

The coordination of logistics and inventory decisions in a supply chain has a significant effect on the supply chain performance. Any attempts to reduce supply chain costs and improve service levels must consider the complex interactions across a wide spectrum of business organizations and their individual replenishment decisions. Until recently, most businesses have primarily focused on improving their internal operations to

* Corresponding author. Tel.: +852 2358 8348; fax: +852 2358 2421.

E-mail addresses: rlau@ust.hk (R.S.M. Lau), jxie@math.tsinghua.edu.cn (J. Xie), xiande@baf.msmail.cuhk.edu.hk (X. Zhao).

¹ Tel.: +86 10 6278 7812; fax: +86 10 6278 1785.

² Tel.: +852 2609 7650; fax: +852 2603 6840.

better serve their immediate customers, and have paid little attention to improving the performance of the entire supply chain by examining the impact of their decisions on other members along the supply chain.

Our research was motivated by a local manufacturer that supplied a standard product to four retailers at different locations. Each of the four retailers made their inventory decisions using simple lot-sizing rules based on their own demand forecasts. The manufacturer made its own production decisions using a capacitated lot-sizing rule, but wanted to investigate the impact of the inventory policies (IPs) used by the retailers on the performance of the supply chain and identify the best inventory ordering policy for the benefit of all members in the supply chain. Four IPs were identified for ease of implementation; these were economic order quantity (EOQ), periodic order quantity (POQ), Silver–Meal (SM), and part-period balancing (PPB). In addition, neither information sharing nor early order commitment was currently used, but these policies would be initiated if such efforts could have been justified by a significant reduction in total supply chain cost or improvement in service level.

To gain a better understanding of the performance of the four IPs under different operational scenarios, we developed a computer simulation model that incorporated a variety of basic environmental and decision variables. The simulation model incorporated many scenarios that would affect the ordering decisions of the retailers and the production lot-sizing decisions of the manufacturer. While addressing the unique issues raised by the local manufacturer and its retailers, we also wanted to subject our simulation to a larger set of operating characteristics so that the results could be generalized and helpful to other supply chains. As a result, we used a combination of demand patterns, capacity, and cost structure variables throughout our simulation. By analyzing the findings from our simulation model, we have sought to provide managerial insights into the following questions:

- (1) How does the inventory policy used by the retailers influence the costs of the supplier, retailers, and the entire supply chain?
- (2) How does the inventory policy used by the retailers influence the service levels of the supplier and the retailers?
- (3) How does the inventory policy used by the retailers influence the value of information sharing?
- (4) How does the inventory policy used by the retailers influence the value of early order commitment?

In addition, our findings can also serve as a building block for future work in this emerging area of research. In the following sections, we first review the related literature and then describe our research designs. Subsequently, we present the simulation model parameters and the results of the statistical analyses. Finally, we describe the managerial implications and conclusions.

2. Literature review

Supply chain coordination is imperative to reducing the inventory and counteracting the demand uncertainty throughout the supply chain. Extensive research has been conducted in recent years to study the phenomenon of volatility amplification in supply chains, widely known as the bullwhip effect. Lee, Padmanabhan, and Whang (1997) identify four main causes of the bullwhip effect: demand signal processing, batch purchasing, price fluctuations, and shortage gaming. Choice of inventory policies, extent of information sharing, and use of early order commitment are often cited as effective means to achieving better supply chain coordination and alleviating the bullwhip effect.

2.1. Inventory lot-sizing policies

The lot-sizing problem has been widely studied under different aspects of demand rates (constant or time varying), demand characteristics (deterministic or stochastic), products (single or multiple), and other production–distribution characteristics. Different solution procedures, commonly known as lot-sizing policies, are available to determine the best ordering quantities and timing. Among the numerous lot-sizing policies and their performance studied in previous research, four well-known ones are investigated here: economic order quantity (EOQ), periodic order quantity (POQ), Silver–Meal (SM), and part-period balancing (PPB).

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