行政院國家科學委員會專題研究計畫　期中進度報告

供銷系統中最佳存貨模式之研究(2/3)

計畫類別：個別型計畫
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執行期間：91 年 08 月 01 日至 92 年 07 月 31 日
執行單位：國立交通大學工業工程與管理學系

計畫主持人：蘇朝墩

計畫參與人員：施志昇、許俊欽、張文珍

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□國際合作研究計畫國外研究報告書一份

執行單位：國立交通大學工業工程與管理學系

中　華　民　國 九 十二 年　五　月　二 十　日

行政院國家科學委員會專題研究計畫成果報告

供銷系統中最佳存貨模式之研究（2/3）

The Optimal Inventory Policy in Supply Chains

計畫編號：NSC 91-2213-E-009-109

執行期限：91 年 8 月 1 日至 92 年 7 月 31 日

主持人：蘇朝墩　　國立交通大學工業工程與管理學系

計畫參與人員：施志昇、許俊欽、張文珍

國立交通大學工業工程與管理學系

一、中文摘要

近年來由於市場競爭激烈，市場需求不確定性大幅增加，下游業者因關鍵零組件短缺造成訂單大幅流失的報導時有所聞。除了市場需求預測的困難外，文獻上已經有許多的研究指出「下游零售商與關鍵零組件製造商未能充分合作、各自訂定最有利的存貨策略」亦是造成供銷體系效率低落的原因。本計劃（第二年）考慮供銷系統中製造商與零售商之間的存貨問題，建立一數學模式，以決定製造商最佳的數量折扣與退貨策略，使系統能夠達到最佳化。本計劃並證明對於製造商而言，數量折扣與退貨策略可視為鏡子的兩面（mirror images），較低的數量折扣可以得到較優惠的退貨條件，而較高的數量折扣所得到的退貨條件較為嚴格。

關鍵詞：數量折扣、退貨策略、經濟訂購量、二階段競賽

Abstract

This project generalized traditional quantity discount problem with return contracts, in which a manufacturer promises to refund some fraction of the retailer's wholesale price if an item is returned, as a two-stage game. In the first stage the manufacturer and retailer determine the inventory level cooperatively. In the second stage, the manufacturer bargains with the retailer for quantity discount and return schemes to maintain channel efficiency. A menu of discount-return combinations is proposed for the manufacturer to make inventory decisions. The developed model will demonstrate that the return policy can be considered as mirror-images of quantity discount strategy. That is, options with more generous return privileges are coupled with higher wholesale prices, whereas the lowest wholesale price comes with very strict limits on returns and a restocking fee for any returned goods.

Keywords: Quantity discount; Return policy; EOQ; Inventory; Two-stage game

二、緣由與目的

The choice of the optimal contract is of

great importance to most manufacturers, especially when supply chains change rapidly these years. Recent studies indicated that the distribution system is currently undergoing dramatic changes, which include the introduction of discounting accompanied by the gradual abolition of a return policy [1]. Quantity discounts have been offered in industries for years and sellers, including manufacturers and wholesalers, use them to entice their customers to purchase more volume or as a response to competition. While the retailer generally has the right to return unsold inventory to the manufacturer within the wide category of products facing uncertain retail demands such as books, magazines, and newspapers, recorded music, computer hardware and software, greeting cards, and pharmaceuticals. However, few studies have developed analytic models to verify manufacturer contract designs with both a quantity discount strategy and a return policy. This project develops a mathematical model that can fulfill this demand.

Quantity discount problems have been studied from the point of view of the buyer initially. These studies focus on determining the economic order quantities for the buyer given a quantity discount scheme set by the supplier [2-4]. Several later studies proposed supplier-side pricing discount schedules and developed models where the supplier offers quantity discounts to increase profit without increasing the buyer's cost. Monahan [5] presented a quantity discount schedule in which the supplier offers a price discount to induce the retailer to increase the lot size. Lee and Rosenblatt [6] altered Monohan's discount pricing model to include explicit constrains and exclude the lot-for-lot assumption. Dada and Srikanth [7] attempted to service the entire system by developing quantity discount models that minimize the system cost. Sellers can reduce their costs without increasing the buyers' costs since these models utilized quantity discounts to achieve channel efficiency, which optimize the channel overall profit. These studies confirmed that quantity discount schemes produce an efficient supply chain by providing an incentive to the buyer to order in quantities greater than the economic order quantity (EOQ). Other researchers [8] proposed two-person game quantity discount model because quantity discount problems are usually solved via buyer-seller negotiation. Corbett and De Grotte [9] dropped the full information assumption in the traditional quantity discount scenario and derived an optimal quantity discount policy under asymmetric information. The studies reviewed above do not consider return contracts which is a major disadvantage considering that they are widely implemented in many industries.

Pasternack [10] developed a return policy with channel coordination. A key result is that coordination can be achieved by allowing the retailer to return all surpluses at a partial refund. Lau and Lau [11] designed a pricing and return-credit strategy for a monopolistic manufacturer of a single-period commodity that proved that a return policy could often be manipulated by a shrewd manufacturer aiming to increase profit instead of losing his profit share to the retailer. Emmons and Gilbert [12] developed a model that incorporated retailer self-interest into the manufacturer's policy decision procedure. It confirmed that both the manufacturer and retailer can benefit from a return policy under certain conditions. Padmanabhan and Png [13] verified the strategic effect of a return policy on retailer competition by highlighting its profitability implications for a manufacturer. Kandel [1] investigated when and how to use return contracts by analyzing the behavior of three different scenarios including vertical integration, a monopolistic manufacturer, and a monopolistic retailer. Padmanabhan and Png [14] presented a framework that explains when and how to adopt a return policy. They proposed a menu of alternative return policies since manufacturers might have difficulties implementing a particular return policy with a mix of retailers that differ in risk aversion, competitiveness, and skepticism. Although the menu includes options with more generous return privileges coupled with higher wholesale prices, no analytic model is proposed to verify the alternatives.

This project addresses how

manufacturers can design a quantity discount scheme and a return policy to achieve channel efficiency. When the supply chain includes return policies, owing to the right to return unsold goods, retailers are encouraged to increase ordering quantity. Therefore, traditional quantity discount schemes must be modified to maintain an efficient system. The whole scenario will be modeled by a two-stage game. At stage one, the manufacturer and retailer determine the inventory level cooperatively; therefore at this stage there is a Nash-Cournot equilibrium. The optimum inventory level is achieved by maximizing the joint profit. At stage two, the manufacturer bargains with the retailer for quantity discount and return schedules to maintain channel efficiency. The results of the second stage depend on the inventory level determined in the first stage and the solution concept for the whole game is subgame perfection.

三、結果與討論

Through the examination of the general model, the following results are obtained:

PROPOSITION 1. *All feasible sets of* $(\Delta w, u)$ *combinations will satisfy the Pareto efficiency.* Where $\Delta w = (w_0 - w)$, u = buyback price per item, w = wholesale price per item, w_0 = baseline wholesale price per item.

PROPOSITION 2. *The retailer's loss due to altering the order is partly offset by the return credit.*

PROPOSITION 3. *A return policy can be considered as mirror-images of a quantity discount strategy. That is, the highest quantity discount comes with very strict limits on returns and a restocking fee for any returned goods whereas a lower quantity discount produces a more liberal returns policy.*

四、計劃成果自評

This project evaluated manufacturer quantity discount strategies and return policies. The general model is developed by a two-stage game. At stage one, the manufacturer and retailer cooperate to determine the channel's optimal inventory level. At stage two, to maintain channel efficiency, the manufacturer design adequate incentive schemes to entice the buyer to change ordering decision. A numerical example was also provided to illustrate the developed model.

The above research results have been accepted for publication in *Journal of the Operational Research Society* (**SSCI**, **SCI**).

五、參考文獻

Kandel E (1996). The right to return. *Journal of Law and Economics* **39:** 329-356.

Rubin PA, Dilts DM and Barron BA (1983). Economic order quantities with quantity discounts: Grandma does it best. *Decision Sciences* **14:** 270-280.

Sethi SP (1984). A quantity discount lot size model with disposals. *International Journal of Production Research* **22:** 31-39.

Jucker JV and Rosenblatt MJ (1985). Single period inventory models with demand uncertainty and quantity discounts: Behavioral implications and a solution procedure. *Naval Research Logistics* **32:** 537-550.

Monahan JP (1984). A quantity discount pricing model to increase vendor profits. *Management Science* **30:** 720-726.

Lee HL and Rosenblatt MJ (1986). A generalized quantity discount pricing model to increase supplier's profits. *Management Science* **32:** 1177-1185.

Dada M and Srikanth KN (1987). Pricing policies for quantity discounts. *Management Science* **33:** 1274-1252.

Chiang WC *et al.* (1994). A game- theoretic approach to quantity discount problem. *Decision Sciences* **25:** 153-168.

Corbett CJ and De Groote X (2000). A supplier's optimal quantity discount policy under asymmetric information. *Management Science* **46:** 444-450.

Pasternack BA (1985). Optimal pricing and returns policies for perishable commodities. *Marketing Science* **4:** 166-176.

Lau HS and Lau AHL (1999). Manufacturer's pricing strategy and return policy for a single-period commodity.

European Journal of Operational Research **116:** 291-304.

Emmons H and Gilbert SM (1998). Note: The role of returns policies in pricing and inventory decisions for catalogue goods. *Management Science* **44:** 276-283.

Padmanabhan V and Png IP (1997). Manufacturer's returns policies and retail competition. *Management Science* **16:** 81-94.

Padmanabhan V and Png IP (1995). Return policies: Make money by making good. *Sloan Management Review* **37:** 65-72.