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(3/3)

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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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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（3/3）

The Optimal Inventory Policy in Supply Chains

計畫編號：NSC 92-2213-E-009-060
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主持人：蘇朝墩　　國立交通大學工業工程與管理學系
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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（第三年）考慮供銷系統中製造商與零售商之間的存貨問題，以協助零售商制定最佳的訂購決策。本計劃建立與分析三個單期存貨模式，藉由最佳化技巧，求出批發價與最佳訂購數量。此外，模式的平衡狀態也列入討論。

關鍵詞：退貨策略、數量折扣、單期存貨模式、漸減成本函數、存貨/生產

Abstract

While returns model in general has been well studied in literature, the returns model considering quantity discounts has not been given much attention, although they are common in many industries. This study considers a supply chain, including one manufacturer and one retailer, and addresses the problem of how a retailer makes ordering decisions under the circumstance that a manufacturer accepts returns accompanied by abolition of quantity discounts. We will establish and analyze three one-period inventory models. Through optimum techniques, the wholesale prices and optimal order quantities are found under different scenario and the system profits are compared. Moreover, the equilibrium of the model is also conducted. Collaboration and comparison of these scenarios are validated through a numerical example.

Keywords: Returns policy; Quantity discounts; One-period inventory model; Decreasing cost function; Inventory/Production

二、緣由與目的

Thanks to global competition, technology innovation, and transportation system development, people can now purchase a greater variety of products at lower prices much more easily. However, this makes it difficult for a retailer to forecast demand and place orders accordingly. As a result, many retailers request the manufacturer honor the return of unsold goods to avoid risk embedded in volatile demand. Recent studies indicated many manufacturers accept returns from retailers. For example, Ten Speed Press accepts book returns from Barnes and Noble; Windham Hill accepts music record returns from Warehouse Entertainment; Chipsoft accepts software returns from Egghead (Kandel, 1996). The inventory model has been developed in numerous recent studies to analyze the scenario of returns. However, the returns model concerning quantity discounts has not been addressed in related literature, despite the fact that it is common in many industries. In this project, we will construct an analytic inventory model to address the returns scenario with regard to quantity

discounts.

Quantity discounts have been offered in industries for years. Manufacturers often use it as a marketing strategy to induce their customers to place more orders. One important assumption for the manufacturers to offer quantity discounts is that the manufacturer's cost will decline when order quantity increases. This assumption implies that production exhibits economies of scale as order quantity increases. In this project, the manufacturer's cost function is assumed to be a decreasing function of the order quantity, which makes the returns model developed in this project a clear distinction from earlier ones.

Early returns models characterized a manufacturer needs to buyback unsold goods when returns is allowed, therefore, the manufacturer usually charges higher wholesale prices to compensate his increased cost. However, these studies always assumed fixed manufacturer' cost per unit, and ignored the fact that a number of specific economic advantages will cause when a retailer places larger order. This project relaxes this assumption and defines the manufacturer's cost per unit as a decreasing function of the order quantity. From our model, the retailer's optimal order quantity will increase when decreasing cost function is assumed. Therefore, the wholesale price should be determined by consideration of not only the price for returns but also the quantity discounts that may result from return policy. This project attempts to develop an analytic model to address such a scenario, and determine both the related wholesale price and optimal order quantity through a one-period inventory model. First, the classical newsboy problem will be addressed, and optimal order quantity will be determined in the model. Second, we will illustrate a model that takes returns into consideration, and show optimal order quantity is more than a counterpart in the newsboy model. Meanwhile, the wholesale price will also be determined in the model. Finally, the returns model will be modified based on consideration of quantity discounts. We demonstrate wholesale price will reduce since larger order quantity causes a manufacturer economies of scale. Meanwhile, we will prove the modified returns model will be more efficient, that is, excess profit will cause in the system. Moreover, the equilibrium of the modified returns model will also be obtained.

三、結果與討論

The returns model

PROPOSITION 1. *The wholesale price in the returns model will increase compared to the one in the newsboy scenario.*

PROPOSITION 2. *The retailer's optimal order quantity in the returns model will be greater than that in the newsboy model.*

The modified returns model with quantity discounts

PROPOSITION 3. *The wholesale price in the returns model modified based on consideration of quantity discount will be lower than its counterpart in the returns model.*

PROPOSITION 4. *The modified returns model will achieve equilibrium when economies of scale no longer exit for the manufacturer.*

PROPOSITION 5. *The modified returns model will be more efficient, that is, excess profit will cause herein.*

四、計劃成果自評

This project aims to characterize a returns model with consideration of quantity discounts, which was accomplished by relaxing the manufacturer's cost function as decreasing with order quantity. First, for the convenience of comparisons at later steps, the classical newsboy problem was addressed and a buyer's optimal order quantity was also determined in this step. Through one-period inventory model, we illustrate that a manufacturer will charge more to compensate the excess cost after accepts return. Then, returns were considered in the newsboy model. The conclusion arrived at was that both optimal order quantity and wholesale price will increase in the returns model with

comparison to their counterparts in the newsboy scenario. Finally, the modified returns model was developed when quantity discounts were considered in the returns model. We demonstrated that the wholesale price in the modified returns model was lower than that in the returns model since a larger order quantity resulting from return policy compensated the manufacturer for his additional cost thus incurred and in turn the manufacturer was willing to provide quantity discounts. The modified returns model with quantity discount was also demonstrated more efficient, that is, excess profits will cause in the system. Moreover, the equilibrium of the modified returns model was reached. The comparison of these three scenarios was captured by a numerical example.

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

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