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Supply chain coordination with quantity discount policy[☆]

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Abstract

This paper develops a model for illustrating how to use quantity discount policy to achieve supply chain coordination. A supplier–buyer system selling one type of product with multi-period and probabilistic customer demand is considered. We first show that if both the buyer and supplier can find a coordination mechanism to make joint decisions, the joint profit in this situation is more than the sum of their profits in the decentralized decision situation. We then show that quantity discount policy is a way that may be implemented to achieve coordination. Our results illustrate that there is a bound of quantity discount in which both sides can accept and the increased profit due to joint decision can be measured using this bound. We finally design a method to divide it between the buyer and supplier, and the optimal quantity discount policy is obtained by using this profit sharing method.

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1. Introduction

One of the main issues of supply chain management is to find suitable mechanisms to coordinate the supplier–buyer relationship in order to achieve overall maximal profit. Traditional relationships between all parties in supply chains are the “trade-off relationship”, so the pricing problem must be the most sensitive factor among the relationships. Traditionally, many researches are taken from the viewpoint that a pricing problem can only benefit one party (that is, the party who is dominant in the chain). But if the two parties coordinate with each other, they may probably find out some pricing strategies so that both parties can improve their own performance. The purpose of this paper is to model a supply chain with one supplier and one buyer and to find a suitable way to achieve coordination.

To achieve coordination, the decision policy characterized by the unit selling price and the order quantity is often coordinated through the mechanism of quantity discounts. That is, the supplier often induces the

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buyer to accept the coordination by quantity discounts. Therefore, research on quantity discounts becomes an ever-increasing important field in supply chain management. In our research, we try to build up a quantity discount model to present a quantitative analysis, and then prove the above standpoint. What's more, we may get some revelatory conclusions to help companies frame feasible pricing strategies.

Quantity discounts have been studied traditionally for a long period from the viewpoints of marketing and operation, respectively. Works in the marketing literature mainly analyze the function of quantity discounts on enlarging companies' sales, while works on operation area focus on the effect of quantity discounts on reducing companies' operating cost, such as ordering cost and inventory cost. In this paper, we try to integrate the above two viewpoints in one single framework. Besides, most of the former researches generally assume that the demand rate is constant or price-sensitive to simplify the problem, and few consider the case when the demand is uncertain, which is exactly considered in our model.

The rest of the paper is organized as follows. In the following section, we provide a brief review of related research and discuss the role of quantity discounts in supply chain coordination. In Section 3, we outline the model assumption and establish the basic model to illustrate the optimal strategies in traditional supply chain relationships. In Section 4, we give the necessary conditions to implement a quantity discount policy under decentralized decision system, and identify the bound of discount rate. In Section 5, we discuss how to establish and realize the coordination mechanism. Finally in Section 6, we conclude and discuss future research.

2. Literature review

In general, supplier planning to offer quantity discounts often faces two decisions: (1) the type of quantity discount to offer, all-unit quantity discount (AQD) (see examples: [Weng and Wong, 1993](#)) or incremental quantity discount (IQD), and (2) the quantity discount parameters for the chosen type of quantity discount. Since the optimal AQD policy is equivalent to the optimal IQD policy in benefiting both the supplier and the buyer if the supplier has complete knowledge of the buyer's information ([Weng, 1995a](#)), the supplier should focus on determining the optimal quantity discount policies instead of considering the selection of quantity discount type.

[Monahan \(1986\)](#) examines a seller practicing lot-for-lot production with an infinite production rate and shows that the seller can increase profits by offering an all-units quantity discount with one price breakpoint to its major customer in order to entice the customer to increase its order quantity. [Lee and Rosenblatt \(1986\)](#) generalize Monahan's model by recognizing that the lot-for-lot assumption may be suboptimal in many cases. The model in that paper simultaneously determines the desired buyer's order quantity and seller's lot size. Instead of the all-units discount schedule featured in both these papers, [Rosenblatt and Lee \(1985\)](#) study a linear discount schedule in the same setting as [Lee and Rosenblatt \(1986\)](#). [Goyal \(1987a, b\)](#) provides further research based on [Lee and Rosenblatt \(1986\)](#), and improves the algorithm. All the above studies assume that the demand rate is constant and independent of the selling price.

In the 1990s, more studies began to relax the above assumption and consider how to realize supply chain coordination. [Weng](#) provides a series of research and contributions in this field. [Weng \(1995a\)](#) considers the case when the demand is the function of the selling price, and establishes the model to illustrate that quantity discounts can increase the amount of demand and achieve Pareto optimization. [Weng \(1995b\)](#) considers a supply chain with single buyer and single supplier. The buyer determines the size of the order placed with the supplier and the selling price charged to customers. Customer demand is a known, deterministic function of that selling price. The supplier, whose profits depend on the buyer's decisions, controls the transfer price and his own production lot size. The focus of the analysis is on determining how to implement a mechanism to divide added profits generated through coordination. Under the assumption

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