

# Channel coordination, trade credit and quantity discounts for freight cost

Gwo-Ji Sheen <sup>\*</sup>, Yu-Chung Tsao

*Institute of Industrial Management, National Central University, Chung-Li 320, Taiwan, ROC*

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## Abstract

In this paper we consider vendor-buyer channels subject to trade credit and quantity discounts for freight cost. We deal with the problems of determining the vendor's credit period, the buyer's retail price and order quantity while still maximizing profits. We focus on how channel coordination can be achieved using trade credit and how trade credit can be affected by quantity discounts for freight cost. We show that profits for both parties increase under channel coordination when the credit period is kept within an appropriate range. This range becomes wider as the discount for freight rates increases. © 2005 Elsevier Ltd. All rights reserved.

*Keywords:* Channel coordination; Quantity discounts; Freight cost; Trade credit

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## 1. Introduction

Any channel member can make unilateral decisions but this decision affects the performance of other channel members, as well as the outcome for the entire channel. If channel members can act in a coordinated fashion, not only will the overall channel cost decrease, but the sales volume and the channel profit can also increase. It has been reported that a company can increase its market share by aligning its channel partners' incentives (Narayanan and Raman, 2004). Activities of upstream and downstream members can be described by a set of flows. A flow is identical to a function, but is more descriptive. The work load for a flow is shared by members at all levels. There exist eight universal flows or functions, such as physical possession, ownership, risking, promotion, negotiation, financing, ordering and payment (Coughlan et al., 2001). The flow representing physical possession can be further separated into two sub-flows: storage and transportation. In this work we analyze pricing, ordering, credit period and quantity discounts for freight cost with considerations of physical possession, ownership, negotiation, financing and payment among channel members. In many practical situations, the customer's order may be delivered in unit loads via air or surface transportation etc. Discounts for larger quantities of freight may occur due to transportation economies of scale, in terms of the number of

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<sup>\*</sup> Corresponding author. Tel.: +886 3 422 9637; fax: +886 3 425 8197.  
E-mail address: [gjsheen@mgt.ncu.edu.tw](mailto:gjsheen@mgt.ncu.edu.tw) (G.-J. Sheen).

unit loads delivered (Shinn et al., 1996). It is assumed that the buyer's ordering cost consists of a fixed setup cost and a freight cost, where the freight cost includes quantity discounts offered due to economies of scale.

Over the years, problems related to channel coordination have increasingly been gaining attention. Jeuland and Shugan (1983) discussed several mechanisms, such as contracts, joint ownership and implicit understanding, needed to attempt to achieve channel coordination. They showed that quantity discounts do help. Banerjee (1986) stated that an optimal joint ordering policy, together with appropriate price adjustment, can be economically beneficial to the members of the channel. Since then Weng (1995) has concluded that quantity discounts must be combined with franchise fees to coordinate the channel. Khouja (2003) considered an integrated three-staged supply chain with multiple vendors and buyers. Recently, Chen and Chen (2005) proposed a joint replenishment program, coupled with a channel coordination practice, and investigated its effect on channel improvement. Krishnan et al. (2004) pointed out several instances where coordinating contracts can lead to cooperative decentralized supply chains that include the retailer's promotional cost.

To induce supply chain partners to behave in ways that are best for the whole channel, companies have to create or modify monetary incentives. However, no one has yet discussed how to utilize the credit period policy as an incentive mechanism. In practice, the seller may often provide forward financing to the buyer. This means a supplier will allow a certain fixed period (credit period) for settling the amount owed to him for the goods supplied. During the credit period, the vendor incurs the capital opportunity cost for the goods sold to the buyer. The main reason that the vendor provides a credit period is to stimulate the end demand for his goods. It will be beneficial to the vendor, if these increased sales are sufficient to compensate for the opportunity cost incurred. In addition, the buyer can take advantage of the credit period to reduce his own cost and increase his profit.

Over the years, a number of papers have been published dealing with economic order quantity problems under conditions of a permissible delay in payments, as described above. Mehta (1968) stated that in terms of the relationship between credit period and demand, the supplier usually expects the profit to be increased by an increase in the sales volume, which compensates for capital losses incurred during the credit period. Fewings (1992) pointed out that the advantage to providing a credit period, in terms of influence on the retailer's purchasing and marketing decisions, is substantial. Some researchers have investigated the effect on inventory policy, from the buyer's point of view, when the vendor offers a specified credit period to the buyer. Haley and Higgins (1973), Chapman et al. (1984), Goyal (1985), Daellenbach (1986) and Rachamadugu (1989) examined the effect of the credit period on the optimal inventory policy. Khouja and Mehrez (1996) investigated the effect of different credit periods on the optimal order quantity. Chung (1998) simplified Goyal's model to search for an optimal solution. Teng (2002) then amended Goyal's model to consider the difference between unit price and unit cost. Chung and Huang (2003) extended Goyal's model to consider the finite replenishment rate.

In addition, some have considered that when the supplier offers a credit period, demand becomes a function of retail price, especially when dealing with a joint pricing and ordering policy. For example, Shinn (1997) considered the pricing and lot-sizing problem under day-term supplier credit. Shinn et al. (1996) dealt with the same problem but when the ordering cost contains not only a fixed cost but also a lot-size dependent freight cost. Then, Shinn and Hwang (2003) discussed the condition of order-size dependent delays in payment. Kim et al. (1995) developed an optimal credit policy with price-dependent demand functions to increase the vendor's profit. Their model dealt with the problem of determining the optimal length of the credit period from the supplier's perspective. They assumed that when a credit period is offered a retailer would consider the retail price and order size together to maximize profit. Abad and Jaggi (2003) considered the vendor's opportunity for capital cost, which is a linear and increasing function of the credit period, when determining vendor and buyer policies.

In this paper it is assumed that the buyer's ordering costs consist of a fixed setup cost and a freight cost which is a function of the ordering quantity. During modeling it is more practical to take quantity freight cost discounts into account. Assuming that the end demand is price sensitive, we deal with the problem of determining the vendor's credit period policy as well as the buyer's retail price and order quantity when maximizing the annual profit. Thus we focus on the influence of quantity freight cost discounts, on how these decisions affect profits and how to utilize the credit period mechanism to achieve channel coordination.

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