



Single-vendor multi-buyer discount pricing model under stochastic demand environment[☆]

Santanu Sinha^a, S.P. Sarmah^{b,*}

^a Complex Decision Support Systems, Tata Consultancy Services, Mumbai 400 093, India

^b Department of Industrial Engineering and Management, Indian Institute of Technology, Kharagpur 721 302, India

ARTICLE INFO

Article history:

Received 21 May 2009

Received in revised form 31 March 2010

Accepted 5 September 2010

Available online 18 September 2010

Keywords:

Supply chain coordination

Heterogeneous buyers

Common order interval

Discount

Evolutionary computation

ABSTRACT

In this paper, a single-vendor multi-buyer discount pricing model has been developed under stochastic demand information. The vendor offers multiple pricing schedules to encourage the buyers to adopt the global optimal policy instead of their individual optimal ordering policy. The global optimal solution ensures that each buyer is assigned to the best schedule with maximum benefit. The results show that coordination benefit increases with increase in the number of pricing schedules. However, the system performance deteriorates with increasing demand variability and service level. Hence, if the system contains high degree of uncertainty or each buyer sets her service level too high, coordination through discount policy may not be an efficient mechanism to enhance channel profitability.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

The essence of Supply Chain Management (SCM) predominantly revolves with the concept of supply chain coordination. In a typical supply chain, independent partners are usually more interested in optimizing their own objective(s) rather than that of the entire system – leading to sub-optimal performance of the supply chain. Therefore, it is an important issue that how an effective coordination mechanism can be established in a decentralized supply chain that will enhance the overall performance of the supply chain close to that of the centralized one. There is already a growing body of academic and industrial researchers from a variety of disciplines who have contributed on different issues of supply chain coordination. They have strived to develop potential coordination mechanisms to eliminate sub-optimal solutions and to improve the system-wide supply chain performance. In the literature, it is termed as channel coordination.

There are several dimensions of supply chain coordination. A systematic review of literature on supply chain coordination has been provided by Arshinder, Kanda, and Deshmukh (2008) and Thomas and Griffin (1996). Among the several dimensions of supply chain coordination, ‘buyer–vendor coordination’ is an important

dimension which focuses on integrating marketing and production policy of buyer–vendor interface to enhance the transaction efficiency of the entire system. Here, the terms ‘seller’ or ‘vendor’ refers to the upstream member supplying/producing the items (e.g. manufacturer or distributor); while the term ‘buyer’ refers to a retailer or the immediate downstream member who sells the items further to the end consumers. Excellent reviews on buyer–vendor coordination models are provided by Goyal and Gupta (1989), Benton and Park (1996), Munson and Rosenblatt (1998), Giannoccaro and Pontrandolfo (2004) and Sarmah, Acharya, and Goyal (2006). Further insights on buyer–vendor coordination models with focus on inventory optimization for two and multiple stage of supply-chain distribution channels have been provided recently by Jaber and Zolfaghari (2008).

In the literature, several contracts (coordination mechanism) have been developed to coordinate between different members of a supply chain. Contract makes formal rules for the transaction between different partners to share risks and rewards in a decentralized supply chain. A contract therefore looks for a Pareto-optimal solution acceptable to each member. Under a typical contract, each member obtains a benefit higher than that of without a contract. The different forms of supply chain contracts can be, quantity flexibility contract (Tsay, 1999), backup agreement (Eppen & Iyer, 1997), buy-back or return policy (Emmons & Gilbert, 1998), revenue sharing contract (Cachon & Lariviere, 2005), and quantity discount (Weng, 1995). However, among the different coordination mechanisms mentioned above, quantity/price discount is a very popular and efficient mechanism often used by

[☆] This manuscript was processed by Area editor Mohamad Y. Jaber.

* Corresponding author. Tel.: +91 3222 283735.

E-mail addresses: santanu_snh@yahoo.com (S. Sinha), spsarmah@iem.iitkgp.ernet.in (S.P. Sarmah).

many organizations to coordinate the business activities (Munson & Rosenblatt, 1998).

In quantity/price discount-based coordination mechanism, control variables are manipulated to reduce total system cost or maximize total system profit and a part of the saving/benefit is distributed in the form of discounts to entice the participating member(s) for the offer. There are several supply chain coordination models based on quantity/price discounts. However, the traditional quantity discount models have been studied mainly from the perspective of the buyer which has addressed the issue of determining optimal ordering policy for the buyer under a given quantity discount schedule set by the vendor (Hax & Candea, 1984; Jucker & Rosenblatt, 1985).

Many researchers have studied the problem from the vendor's perspective where the issue is how to design effective discount policy to coordinate a vendor dealing with a single/multiple buyer(s) under various contexts. In this sense, Monahan (1984), Lee and Rosenblatt (1986), Li and Huang (1995) have developed coordination models in a single-vendor single-buyer framework. The primary objective of such models is to devise effective quantity discount policy to reduce operating cost and increase overall profit of a supply chain under various modeling assumptions. An exhaustive review on related models has been provided by Sarmah et al. (2006) and Ben-Daya, Darwish, and Ertogral (2008). These models have shown that under a typical price/quantity discount policy, every member obtains a better pay-off – as compared to their non-coordinated approaches.

However, single buyer–vendor dyad coordination models have serious limitations in real life situations. In the context of current B2B business model, most of the manufacturers distribute their products to the end users through several distributors/retailers in a geographically dispersed global network. The distributors/retailers could be wholly owned subsidiaries (e.g. Sherwin-Williams with 2012 retail paint outlets), franchisees (e.g. Chevrolet with 4510 franchised dealers in US), or independent (e.g. Skyway Luggage with more than one thousand retailers) (Ingene & Parry, 1995). Further, the buyers/retailers serving different locations could be heterogeneous in nature due to their varied cost structures and market demand. For example, Xerox sells personal copiers through higher-cost department stores and lower-cost mass merchandisers (Balachander & Srinivasan, 1998). Thus, the challenge is how a typical vendor should design a quantity discount policy to reduce operating cost or increase revenue while dealing with multiple heterogeneous buyers. A stream of literature has explored single-vendor multiple-buyer supply chain coordination models with quantity/price discount policy. These models have shown that a common discount policy offered by the vendor can maximize the system profit (Chen, Federgruen, & Zheng, 2001; Hwang & Kim, 1986; Ingene & Parry, 1995; Jeuland & Shugan, 1983; Kim & Hwang, 1988; Moorthy, 1987).

An interesting framework of channel coordination with multiple buyers has been provided by Viswanathan and Piplani (2001). The authors have proposed a strategy where the vendor specifies common replenishment epochs/periods (CRE) and entices all buyers to replenish only at those time periods in return to a price discount offer. The optimal CRE and the amount of discount to be offered were determined under the framework of a Stackelberg leader–follower game – assuming the vendor to be the leader. Mishra (2004) has extended the CRE based coordination model and has shown that implementation of 'selective discount' can yield better pay-off than that of 'inclusive discount'.

However, from the literature, it has been found that most of the models are limited to either single price break schedule (Hwang & Kim, 1986) or continuous/infinite price-break schedules (Abad, 1988; Dada & Srikanth, 1987; Lal & Staelin, 1984; Rosenblatt & Lee, 1985). Further, it has been shown that a single price break pol-

icy is sub-optimal for suppliers dealing with multiple buyers with varied cost structures; and hence, the policy does not have much practical applicability (Wang, 2002). On the other hand, implementation of continuous quantity/price discount schedules with infinite number of price-breaks does not have much practical significance as it increases billing/account complexities (Munson & Rosenblatt, 1998). Thus, in most of the real business scenarios, vendors offer unified discrete quantity discount schedules to their customers. Such pricing schedules usually have multiple but finite break points and are required to comply with fair trade laws under Federal Robinson-Patman Act. Moreover, when the buyers are heterogeneous in nature, finding the suppliers' optimal pricing schedule is difficult and most of the derived techniques are very complex in nature and requires to be handled with efficient search algorithms (Sinha & Sarmah, 2010).

In order to address the above mentioned issue, Chakravarty and Martin (1988) have developed a single-vendor multi-buyer model with a common order interval technique. The model determines the optimal order interval time by minimizing total cost function and also considers a mechanism to split the coordination benefit by a certain proportion among the partners. The authors have developed pricing schedules to segregate the buyers into two groups. However, their modeling efforts are limited to two groups only and for both the groups, optimal ordering time is the same while the selling prices are different.

Wang (2002) has developed a single-vendor and multi-buyer discount pricing model with several price-breaks. However, the model has determined optimal price for each buyer rather than grouping buyers into different clusters and deriving optimal pricing strategy for each cluster. This kind of discount policy becomes highly complex as the number of buyers increases. Similar limitation is also noticed in Feng and Viswanathan (2007) where the authors have considered common replenishment epoch (CRE) as a pricing policy for heterogeneous group of buyers to coordinate the buyer–vendor system under stochastic demand environment.

Recently, Sinha and Sarmah (2010) have developed a single-vendor multi-buyer supply chain coordination model through optimal discount pricing policy. The model groups all the buyers into different discrete clusters and determines the discount schedule for a particular cluster using an evolutionary search technique. However, the model is limited to consider only deterministic demand for any buyer which is highly restrictive assumption in terms of practical applicability.

Thus, to capture a more realistic situation, this paper extends the earlier work of Sinha and Sarmah (2010) under stochastic demand environment. Here, we address the issue of designing pricing policy for single-vendor multiple heterogeneous buyers with stochastic demand from the vendor's point of view. Under this framework, the vendor offers multiple pricing schedules for the buyers where each pricing schedule consists of a discounted selling price and the corresponding common order interval. Assuming each buyer to be rational, the modeling efforts ensures that under the optimal pricing policy, each buyer's self-selection of local optima also leads to global optima. In this sense, under a feasible pricing policy, no party in the system is worse off as compared to the situation when no price discount was offered. The pricing policy also shows the mechanism to split the coordination benefit almost equally among the seller and the buyers cumulatively to achieve a welfare solution (Chakravarty & Martin, 1988; Sinha & Sarmah, 2010). Finally, the search technique of grouping and deriving optimal pricing schedule(s) is efficiently handled by an evolutionary algorithm (genetic algorithm) which has found significant application in solving complex optimization problems (Deb, 2000).

The remainder of the paper is organized as follows: Section 2 contains the notation and the modeling assumptions. The mathematical model has been developed in Section 3 while the solution

Download English Version:

<https://daneshyari.com/en/article/1134747>

Download Persian Version:

<https://daneshyari.com/article/1134747>

[Daneshyari.com](https://daneshyari.com)