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A joint venturing of single supplier and single retailer under variable price, promotional effort and service level



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ABSTRACT

This paper analyses a two-echelon supply chain composed of one supplier and one retailer. The market demand is assumed to be uncertain and considered to be retail price dependent and dependent on the supplier's service level and on the retailer's promotional effort. The unsold items at the retailer are repurchased by the supplier at a price less than the sales prices. Conversely, the retailer encounters shortages because the demand is naturally uncertain. The optimal order quantity, selling price, promotional effort and service level are evaluated analytically as well as numerically for single period news-vendor-type demand patterns. The profit functions of the supplier and the retailer are analysed and compared in accordance with Stakelberg and integrated approaches. Computational results show that an integrated system is always beneficial for the members of the chain.

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1. Introduction

The objective of supply chain management is to generally target performance enhancement by either reducing costs or escalating profits. There are vast methods of doing either; therefore, the most effective means of profit enhancement is boosting market demand by various means. Given today's furiously competitive market scenario, the foremost objective of an efficient supply chain manager is to consider all of the issues pertaining to demand enhancement. The concerned management must address the issues that affect the market demand and outline the strategies of the chain accordingly. The very first step is to identify the most sensitive factors that improvise market demand. Of all such factors, the product's retail price is the most important factor that affects demand. Usually the demand decreases with the retail price increment. In addition to the retail price, the market demand depends on certain non-price factors such as the quality of the product, the brand value, and the availability in the market. There are few factors other than these non-price factors that positively improve the

product's demand. For example, different types of promotional activities adopted by supply chain members are to enhance the demand of the commodity. Such activities include advertisements, free gifts, delays in payment, and discount offers. If a huge number of consumers become knowledgeable regarding the salient attractive features and usefulness of the product through promotional activities, the demand for the product will improve. Another fruitful means to enhance demand is furnishing after-sales service. Bestowing before and after-sale servicing such as bestowing free servicing and repairing through a stipulated time period or facilitating replacement of the product if damaged or underperforming are generally very helpful to capturing a wide range of customers. Very often, providing a high service level or investing greatly in promotional activities is very costly and may cause high expenditure levels. Therefore, chain members must invest in an optimal desired effort level to increase potential customers. In both inventory and supply chain literature, researchers have determined sales effort as a factor that increases demand in a single retailer scenario as well as a tool that benefits the retailer in capturing more of the total market demand.

In recent decades, there has been extensive research regarding different forms of demands having price dependency; for example, Wee (1997), Qin et al. (2007) and Ghosh et al. (2011) considered linear price dependent demand, and Ouyang et al. (2008) and Ziaee

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and Bouquard (2010) assumed the iso-elastic form of price dependency. Huang and Li (2001), Huang et al. (2002) and Li et al. (2002) studied the role of vertical co-op advertising efficiency with respect to dealings between a manufacturer and a retailer through brand names. Bernstein and Federgruen (2007) examined coordination mechanisms for supply chains under price and service competition. Lau and Lau (2003) explicitly studied the effect of different demand patterns on the optimal decisions of a multi-echelon supply chain. Panda (2011) addressed an optimal pricing and replenishment policy in a declining price sensitive environment under continuous unit cost decreases. Panda et al. (2012) studied the problem of optimal pricing and economic order quantity in a stock and price sensitive demand environment. Javid and Hoseinpour (2011) investigated the coordination of co-op advertising decisions in a supply chain with one manufacturer and one retailer. Wang et al. (2011) coordinated co-op advertising models with one manufacturer and two competitive retailers. Recently, Javid and Hoseinpour (2012) re-addressed the static, single-period co-op advertising model that was introduced and studied earlier by Huang and Li (2001) and subsequently by several other authors using game theory.

Despite the fact that sales efforts are utilised in the real world to promote huge sales, the quantity of effort and money expended on providing after-sale service and the impact of this usually differ from product to product. It is generally observed that the effort level usually varies with the price of the product. If the selling price is higher, higher sales effort and facilities offered after sales associated with the product are needed. Therefore, the resulting effect of providing sales efforts to a particular product on the profits earned from selling the product by channel partners must be examined before deciding whether to provide such a facility to end customers. The effect also depends on the company's reliability and brand value; these play vital roles to control and determine the effect of such efforts on demand. Remembering the previously noted facts, a significant quantity of research has been performed in recent years on how the sales effort affects the market demand; the research also includes how to exert such effort efficiently. Jorgensen et al. (2000, 2001, 2003) and Jorgensen and Zaccour (2003) extensively studied the long-term multi-period co-op advertising relation between a manufacturer and a retailer through dynamic models. Krishnan et al. (2004) showed that buy-backs with promotional cost-sharing agreements can be coordinated. Service as well as promotion thus affect both consumer demand and the retailer's sales motivation. Several authors have established that certain main results and conclusions in the supply chain analysis may be affected by the choice of the demand model; in addition, the results are sensitive (Jeuland and Shugan, 1988; Granot and Yin, 2007). Roy and Chaudhuri (2010) analysed a model of perishable items with time and price dependent demand considering the time value of money. Recently, the EOQ (economic order quantity) and the EPQ (economic production quantity) model for price and promotional effort sensitive demand have been studied extensively by Taleizadeh et al. (2015a, 2015b), Cardenas-Barron and Sana (2014, 2015) and Cardenas-Barron et al. (2014). Modak et al. (2015) introduced corporate social responsibility in a two-echelon dual-channel supply chain model in which the coordination of all unit quantity discounts using a franchise fee agreement and dividing the surplus profit through bargaining are discussed analytically.

This paper studies the effect of promotional effort and after-sales service level on demand uncertainty, within a two-echelon single-period NV (newsvendor) environment using the pricing strategies of a profit maximizing supplier/retailer. According to the author's best knowledge, no one has yet used promotional efforts coupled with before/after-sales service efforts as a tool for

enhancing the demand while simultaneously using buy-back contracts for supply chain coordination. Most cited papers solely consider the effect of price. It is also observed that the demand is not only dependent on the product's price but also on the manufacturer's effort. To develop the market, the supplier/agent applies selling efforts for the product such as stipulation of the product information in the market, advertisements, expenditures on social activities, greening efforts, free repair or after-sales service; these are very common in practice. Coexistence of the above factors is common in most retail sectors as strong efforts to improve market demand. From the above literature, the consequence of promotional effort on supply chain coordination as well as the influence of supplier's extra marketing efforts are ignored, particularly in the NV environment area in which the demand is stochastic in nature. The literature on the NV is very voluminous and well known in terms of applicability. Excellent summaries on the subject appear in Petruzzi and Dada (1999), Silver et al. (1998), Khouja (1999), Chan et al. (2004), and Lau and Lau (2001). A primary difficulty in this type of research is the problem of designing contracts that will be rendered beneficial to the various members of the chain. The main objective of the classical newsboy problem is to maximize the expected profit. Many other approaches have also been included in the classical newsboy problem, for example, the mathematical programming approach was used to find the solution. Wang (2010) studied a game theoretic approach including multiple newsvendors with loss aversion preferences that were competing for inventory from a risk-neutral supplier. Ozler et al. (2009) proposed the multi-product newsboy problem under a Value at Risk (VaR) constraint. Soni and Shah (2011) studied an EPQ model for deterministic, stochastic or fuzzy demand to minimize the cost function. Cardenas-Barron et al. (2012) proposed a heuristic algorithm to determine an optimal solution of the vendor management inventory system with a multi-product and a multi-constraint based on EOQ with backorders considering two classical backorders costs: linear and fixed. In newsvendor modelling, the noteworthy works of Lau and Lau (1988), Wu et al. (2007), Taleizadeh et al. (2012), and Sana (2011, 2012) should be noted.

In our model, we develop a two-layer supply chain consisting of one supplier and one retailer. The demand of the end customers is stochastic because the arrival of the customers is not certain in practice. The demand function here has been considered as a function depending on three prime factors: price, promotional effort as well as sales service efforts. We have considered the linear demand function case. Because the demand is uncertain, the retailer may overstock or understock the products. Because of overstocking, the unsold items are returned to the supplier at a lower price than the supplier's wholesale price, whereas the retailers must bear the penalty cost for understocking. We have developed the profit functions for the supplier and the retailer while maintaining the price-promotional effort and sales service effort-dependent demand in the account. These supplier and retailer profits are formulated and optimized by utilizing Stakelberg and integrated approaches. We have also conducted a comparative study among the above approaches, which ultimately suggests that the integrated system provides the best profit.

The remainder of this paper is organized as follows: Section 2 explains the fundamental notations and assumptions, Section 3 provides mathematical formulations and an analysis of the model, and in Section 4, we discuss numerical examples. Section 5 presents a conclusion regarding this paper's findings.

2. Fundamental assumptions and notation

The following assumptions are made to develop the model:

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