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Pricing and rebate policies in the two-echelon supply chain with asymmetric information under price-dependent, stochastic demand

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Abstract

This paper analyzes the manufacturers' strategy of optimizing the direct rebate to the final customer and the wholesale price to a profit-maximizing retailer with a price-dependent stochastic demand. The manufacturer possesses full information about the cost and the functional relationship among demand, price and rebate, but may or may not know about the nature of the underlying demand uncertainty faced by the retailer. The conditions under which a retailer benefits from passing on such information are identified. The main features of the model are illustrated analytically and numerically, using linear or iso-elastic demand functions, with additive or multiplicative error structures. Several important implications have been derived, especially those dealing with price and rebate pass-throughs and with the cost to the manufacturer of asymmetric information.

Keywords: Two-echelon supply chain; Newsvendor problem; Pricing; Marketing/operations interface; Direct rebate; Asymmetric information

1. Introduction

This paper studies the effect of information asymmetry about demand uncertainty, within a two-echelon single-period newsvendor (NVP) environment, on the pricing strategies of a profit-maximizing manufacturer/vendor/wholesaler, intent on bypassing the retailer through giving a direct rebate to the end customers in an effort to stimulate sales. The retailer has full information about demand behavior with respect to price and the

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rebate and about the nature of the demand uncertainty and is expected to make the pricing and ordering decisions to maximize its expected profit. The asymmetry relates to the manufacturer possessing either no knowledge (Scenario 1) or full knowledge (Scenario 2) about the demand error structure. The ability of the manufacturer to arrive at the best price and rebate is conditioned by the level of information that the manufacturer has about the uncertainty faced by the retailer as well as the retailer cost and demand function. In Scenario 1, the manufacturer's optimal pricing and rebate policies, with no knowledge about the uncertainty, hinge upon the incorrect assumption that the retailer's own pricing and ordering policies reflect a deterministic demand. In Scenario 2, embedded in the optimal policies of the manufacturer are the retailer's optimal order quantity and retail price, since both parties possess full information about the uncertainty.

The literature on the NVP is well known in terms of applicability and quite voluminous in size. Excellent summaries on the subject appear in Chan et al. (2004), Khouja (1999), Lau and Lau (2001), Petruzzi and Dada (1999) and Silver et al. (1998). The majority of these papers deal with the one-echelon problem, normally in the form of a retailer trying to decide upon the profit-maximizing ordering quantity and selling price, faced with a fixed purchase price, a stochastic demand, a salvage value for unsold merchandise and a shortage cost for unfulfilled demand. Coordination problems in decentralized two-echelon NVP problems, where the vendor and the retailer do not form an integrated entity, have been recently considered (e.g. Koulamas, 2006; Sharmah et al., 2006; Wang, 2005). A related issue here is the amount of market information each party has. A primary difficulty in this type of research is the problem of designing contracts that will render beneficial to the various members of the chain sharing this type of information (e.g. Tsay et al., 1998; Agrell et al., 2004). This explains why the simple assumption of symmetric information is the norm (e.g. Emmons and Gilbert, 1998; Lau and Lau, 1999). As a result, the retailer and manufacturer share the same market information and hence both channel members perceive the same retailer's demand function. Lau and Lau (2001) consider the asymmetric case where the retailer has better demand information than the manufacturer and the latter may or may not be aware of this fact. Further recent work on the two-echelon case of asymmetric information include Corbet et al. (2004) on supply control, Gurnani and Shi (2006) with asymmetric information on supplier reliability and Iyer et al. (2006) on information and inventory.

This paper extends the current research along several lines. First, it analyzes a given information characteristic, namely the uncertainty of the demand. Second, it considers the effect on the manufacturer of direct rebates, a trade incentive widely used in sales promotion campaigns (e.g. Agri Marketing, 2006; Automotive News, 2006; Mouland, 2004) but largely ignored in the NVP literature, with the possible exception of Arcelus et al. (2005, 2006) and Khouja (2006). A recent review of the literature on sales promotions appears in Neslin (2002). A manufacturer may prefer rebates to other trade incentives, for the following primary reasons. Contrary to temporary price discounts, rebates lessen the attractiveness to retailers of forward buying to take advantage of the discount, but without passing on these savings to the end customers. It also may encourage some end users to purchase the merchandise in question, looking at the rebate as a price discount, but the trade incentive may cost less to the manufacturer as only a few customers redeem the rebate (e.g. Arcelus and Srinivasan, 2003; Dhar and Hoch, 1996; Hardesty and Bearden, 2003; Mouland, 2004; Reibstein and Traver, 1982). Third, it extends Emmons and Gilbert (1998) to consider asymmetric information and a variety of demand forms and error structures, rather than using only linear demand and a multiplicative error. Fourth, it extends Lau and Lau (2001) to use a price-dependent demand, more in accordance with the tenets of microeconomics. We provide examples to show that the manufacturer's optimal wholesale price with full information may be higher or lower than that without information, depending upon the nature of the demand function and of the error structure. This in turn leads to the identification of situations where the retailer will be better off providing the demand error information to the manufacturer.

The paper is organized as follows. The next section includes the common elements to the manufacturer's decision process, as well as the optimality conditions of the two scenarios. To better measure the effect on profitability of the rebate, each scenario presents the manufacturer's optimal policies with and without rebate. This is followed by a numerical assessment of the differences and similarities between these policies. The Conclusions section completes the paper. The notation appears in Table 1.