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On supply chain coordination for false failure returns: A quantity discount contract approach

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ABSTRACT

A large proportion of consumer returns fall into the category of false failure returns, which refer to returns without functional defects. In this paper, we consider profits resulting from exerting costly effort to reduce false failure returns in a reverse supply chain. The supply chain as a whole has a strong incentive to reduce such returns for cost saving. However, retailers typically enjoy a full credit provided by suppliers for returns, so they may not have sufficient incentives to exert enough effort for supply chain profit maximization. In some scenarios retailers may even have the motivation to encourage such returns. We suggest using a coordination contract to resolve this profit conflict. We introduce a quantity discount contract which specifies a payment to the retailer with an amount exponentially decreasing in the number of returns. We present explicit forms of such contracts given different assumptions about the distribution of the number of returns. We also prove that the contract is Pareto improving. Besides, it is shown that when the contract is applied in a closed-loop supply chain, it can deter retailer's potential incentive to encourage returns. Moreover, some modifications of the contract can lead to easy allocation of supply chain profit.

1. Introduction

Many firms now offer liberal return policies that allow customers to return products for any reason within some time (typically 90 days) after the purchase. The volume of consumer returns is rapidly increasing and has already exceeded \$100 billion per year in the U.S. (see, for example, Stock et al., 2002). However, a large proportion (95% in the electronic industry in the U.S. by Lawton, 2008) of these returns are results due to reasons other than functional defects of the products. For example, a customer may regret over an impulse purchase, or find out later that the product is not suitable, or too difficult, to use (Su, 2009). This kind of returns is referred to as "false failure returns" in Ferguson et al. (2006). This is the main subject we are going to study in this paper.

Two other closely related concepts here are the closed-loop supply chain and the reverse supply chain. According to Guide and Van Wassenhove (2003), the process of materials flowing from suppliers for manufacture and then to retailers for sale and finally purchased by customers is referred to as a forward supply chain. Then, in case of returns, the process of retailers accepting the returned products from customers and then transferring them back to suppliers for possible remanufacturing is referred to as a reverse supply chain. The forward and the reverse chains together form a closed-loop supply chain. Typically, the studies of a reverse supply chain are motivated by two reasons. The first one concerns the sustainable development of the earth. Since re-collected products may be used for recycling, we can reduce trash by converting these products into treasures (a discussion can be found in Chung and Wee, 2008). Besides environmental considerations, the economical reason is that the material value involved in returns is now too significant to be ignored. Studies show that proper design of a reverse supply chain can even bring in extra profit to a firm in addition to lowering the cost (see Guide and Van Wassenhove, 2003).

Although much existing literature focus on the planning or the impact of remanufacturing (see, for instance, Guide et al., 1997), this paper studies the incentive conflicts in a reverse supply chain concerning exerting costly effort to reduce false failure returns. Possible ways for suppliers to exert such effort may include improving the manuals and making them more readily intelligible so as to reduce the difficulties of use; or the suppliers may ameliorate the design of the products and render them more user-friendly, adding the blue-tooth function to mobile phones or laptop computers may be a case in point. For the retailers' part,

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since they are the ones directly matching customers with different products, if they make extra effort to communicate and interact with customers more, they can understand the needs and the preferences of customers and better match them with proper products. All these costly actions can be taken to reduce the amount of false failure returns.

Reducing such returns is usually highly beneficial to suppliers. Suppliers who value their brand image typically provide a full credit to retailers and take the returned products back. Hence extra uncertainty in inventory volume is brought in and associated administration cost occurs in addition to the extra refund payment to the retailers (Nenes et al., 2010). And by Guide et al. (2003), during the take-back process, suppliers not only bear goodwill cost but also have to pay the costs of possible test, refurbishment, remanufacturing, recycling or loss in value of the products especially for innovative or fashionable ones (see Guide et al., 2006, for a discussion). The sum of these costs may be substantial. However, if the amount of returns is reduced, such loss can be avoided. On the other hand, costs also incur to retailers in case of false failure returns. For example, a lot of retailers offer money-back guarantees which provide full refund of the products' retail price to customers for any reason of returns, because of competitive pressure if such policies are common in the business or out of the consideration that such guarantees may give customers more confidence in making purchases and hence simulate sales (Davis et al., 1995); in addition, retailers also have to bear the goodwill cost or fees of re-processing and transportation. However, since they typically receive generous full credits of the wholesale price from suppliers, their incentives of reducing such returns are usually lower, especially when the cost of implementing strategies to reduce the number of false failure returns outweighs the cost that can be saved. In some circumstances, retailers may even want to actively push the level of such returns, for example, if the product has a poor demand, because doing so may act as a way to return the inventory to the supplier. Hence, profit conflict arises between the supply chain and the retailer in determining the optimal level of effort to be exerted to reduce false failure returns.

This paper is devoted to designing a coordination mechanism to resolve the profit conflict in a reverse supply chain in the presence of false failure returns. To simplify our analysis, we consider a supply chain with one retailer and one supplier. Attention is paid to the profits and costs associated with reducing false failure returns by costly effort. The operations in a forward supply chain are thus not considered in the first part of our discussion. We shall then incorporate the operations in both the forward and the reverse supply chains in the latter section. Consider the following events occurring in sequence: when a customer brings in a false failure return, typically a full money refund is provided by the retailer who later gets a full credit of the wholesale price from the supplier and returns the product. Meanwhile, we assume that effort can be exerted to reduce the volume of false failure returns. Given the above discussions, it is reasonable to impose another assumption that the supplier has already exerted all his/her effort, and that the retailer takes all possible remaining effort and the associated costs. We show that the profit-maximizing level of effort chosen by the retailer is always lower than the one chosen from the supply chain's point of view. This is sub-optimal since the supply chain profit is eventually to be split between the retailer and the supplier.

The origin of this problem is that the retailer bears all the costs yet only enjoys partial benefit of reducing the amount of false failure returns. Consequently, we aim at designing a contract specifying a way for the supplier to share the costs by making a payment to the retailer, so as to induce the retailer to exert a globally optimal level of effort. We show that under certain conditions, such contract is also capable of improving both parties' profits simultaneously. Specifically, the contract payment in our proposed coordination contract is exponentially decreasing in the returned amount. Exponential decrease is assumed here because this function is smooth, which provides ease of implementation. More importantly, it is reasonable to have contract payments decreasing in the number of false failure returns for, at least, two reasons. Firstly, it is hard to directly contract on the level of effort since it is very difficult, if not impossible, to be quantified. Secondly, a lower level of returns is rather credibly indicating that retailers are exerting effort, and thus should be compensated more in this case. To derive a closed-form formula for determining contract parameters, we consider three commonly used probability distributions for the number of false failure returns. Firstly, we consider a geometric distribution. Since a false failure return is the result of a consumer's individual decision rather than because of the quality of the product itself, it is reasonable to assume that they are stochastically independent. Consequently the geometric distribution, which is memoryless and assumes independence of returns, is a reasonable distribution for the number of false failure returns. Secondly, the number of returns is assumed to have a Poisson distribution. The results obtained under the Poisson distribution would be more accurate if the sales volume is large or the period under consideration is long. Lastly, we consider the case of a normal distribution. Two numerical examples are given to demonstrate the effectiveness of the contract.

Note that the coordination contract proposed here specifies a contract payment decreasing in the number of false failure returns. This resembles the quantity discount contract which is a coordination contract in a forward supply chain specifying a wholesale price decreasing in the order quantity. Thus we shall refer to our contract as a quantity discount contract throughout the paper. Quantity discounts have been shown to be able to reconcile the profit conflicts within the supply chain in making decisions on the inventory level in the case with a single supplier and a single retailer (Jeuland and Shugan, 1983). The analysis has later been generalized to demonstrate that quantity discount contract is able to achieve coordination for a supply chain with one supplier and multiple homogeneous retailers (Ingene and Parry, 1995) and also for a supply chain consisting of a single supplier and a large number of heterogeneous retailers (Lau et al., 2008). A general literature review of quantity discounts can be found in Dolan (1987), and Wilson (1993) can be referred to for an encompassing discussion of other non-linear pricing schemes. The design of other coordination contracts for a forward supply chain has also been extensively studied (Cachon, 2003). Although the findings in these studies may not be directly applied in the context of a reverse supply chain due to the differences in nature of the two, for example, in terms of the timing or the way of transaction, however, certain results may offer a high reference value. For example, in Ferguson et al. (2006), a modification of the rebate contract which is a coordination contract for a forward supply chain is demonstrated to be able to resolve incentive conflicts in the context of a reverse supply chain. In another paper, Xiao and Shi (2010) design a buyback contract to coordinate a reverse supply chain with the presence of consumer returns and study how refund amounts specified in the return policies effect profits.

In this paper, we adopt basic settings similar to the ones in Ferguson et al. (2006), but our work here still contributes to the literature in two aspects. First, note that the contract designed here is a quantity discount contract which is different from the rebate contract in Ferguson et al. (2006). We believe that our contract has advantages over the rebate contract because the continuously decreasing form provides more direct incentive to