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Price discounts in exchange for reduced customer demand variability and applications to advance demand information acquisition ☆

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Abstract

We consider a supplier and a customer operating under a service agreement that requires the supplier to cover the random customer demand with high probability. To fulfill the service agreement, the supplier carries a certain amount of safety stock. The customer has some bearing on its demand variability, possibly through activities such as acquiring advance demand information, employing more sophisticated forecasting techniques or smoothing its product consumption, but these activities bring an extra cost to the customer. Since a reduction in the customer demand variability helps the supplier reduce its safety stock, the supplier is willing to offer a price discount in exchange for reduced demand variability. We examine a pricing scheme where the supplier assesses its potential cost savings from a reduction in the customer demand variability and returns a fraction of these cost savings back to the customer through a price discount. We show that both parties realize cost savings under such a pricing scheme, examine the efficiency issues and consider the case where the customer does not reveal certain cost components accurately.

Keywords: Contracts; Pricing; Advance demand information; Supply chain

0. Introduction

Although conventional inventory models treat the customer demand as an exogenous random process, there are many situations where the customer can affect certain aspects of its demand process through activities such as acquiring advance demand information, employing more sophisticated forecasting techniques or smoothing its product consumption. Essentially, the outcome of these activities is to reduce the customer demand variability, which, in turn, benefits the customer through increased fill rates and the supplier through reduced inventories. However, although both the supplier and the customer benefit from these activities, the costs associated with them are usually born only by the customer. Consequently, the customer may pursue these activities in a much more limited scope than the supplier desires, and the supplier may have to share the costs of these activities with the customer or provide other incentives.

In this paper, we consider a supplier and a customer operating under a service agreement that

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requires the supplier to cover the random customer demand in each time period with high probability. The customer has some bearing on its demand variability, but this requires the customer to incur an extra cost. Early in the paper, we do not explicitly specify how the customer can affect its demand variability, but we later give a specific example where the customer can do this through advance demand information acquisition. A reduction in the customer demand variability helps the supplier reduce the safety stock that it needs to fulfill the service agreement, and the supplier is willing to offer a price discount to motivate the customer. We propose a pricing scheme that is motivated by the idea that the supplier should return a fraction of its potential cost savings that can be realized by the reduction in the demand variability back to the customer through a price discount. The result is a pricing scheme where the price charged to the customer is a linear function of the standard deviation of the customer demand. We show that both the supplier and the customer realize cost savings under such a pricing scheme. We examine the efficiency issues and consider the case where the customer does not reveal certain cost components accurately.

Our work is motivated by the relationship between a just-in-time manufacturer and its raw material supplier. In each time period, the supplier faces the demand for the raw material that the manufacturer needs for production in the current time period. Through better planning and forecasting techniques, the manufacturer can anticipate the need for the raw material in the future and reduce its demand variability, which, in turn, decreases the safety stock of the supplier. In our setting, the price discount is initiated by the supplier with the goal of reducing its safety stock requirements. Price discounts initiated by the suppliers often occur in industries where there are only a few suppliers and a few consumers of some raw material, and a specific supplier-consumer pair operates in a close relationship. Such situations are common in high-tech industries. As pointed by Lal and Staelin (1984), a large supplier may also initiate a price discount when supplying many small consumers. Our results may also be applicable in this setting by interpreting the customer demand in this paper as the total demand from all consumers.

The literature on exploiting different forms of information to increase the efficiency of inventory systems is quite rich. Several papers quantify the value of real-time demand information coming from the retailers in a supply chain. Lee et al. (2000) consider a two-stage supply chain where the customer demands at different time periods are correlated and show that the value of real-time demand information is significant especially when the demand quantities in different time periods are highly correlated. Cachon and Fisher (2000) study a distribution system with one warehouse and multiple retailers, and point out that the value of real-time demand information can be small when compared with the benefits of reducing the lead times or batch sizes. Gavirneni et al. (1999) quantify the value of real-time demand information in capacitated production and distribution systems. Bourland et al. (1999) consider a setting where the ordering cycles of the supplier and the retailer are not aligned. They show that the supplier can make better ordering decisions if it knows the amount of demand that occurs at the retailer between the time of the last order of the retailer and the time that the supplier places an order. Another form of information that is used to increase the efficiency of inventory systems is the forecast updates. Gullu (1996, 1997) studied production and distribution systems where the demand forecasts get more accurate over time and show that the inventory costs can be reduced if one explicitly takes the forecast updates into consideration.

There is also work on quantifying the value of advance demand information. Hariharan and Zipkin (1995) consider a continuous-time inventory control model where the customer demand becomes known τ time periods in advance. They refer to τ as the "demand lead time" and show that the effect of increasing the demand lead time is exactly the same as the effect of decreasing the supply lead time. Karaesmen et al. (2002, 2004) study production systems with advance demand information where the main difference from Hariharan and Zipkin (1995) is the limited production capacity modeled through a single-server queue. Ozer (2003) studies the value of advance demand information in distribution systems. Gilbert and Ballou (1999) examine the reductions in the inventory costs due to advance customer commitment and give a queueing model to assess the impact of advance customer commitment on the capacity requirements. Van Donselaar et al. (2001) and Thonemann (2002) consider the value of advance information in a project environment. Several companies submit proposals for projects. If a company manages to get a project, then it needs