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Make-or-buy service capacity decision in a supply chain providing after-sales service

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ABSTRACT

We consider a supply chain comprising a manufacturer and a retailer. The manufacturer supplies a product to the retailer, while the retailer sells the product bundled with after-sales service to consumers in a fully competitive market. The sales volume is affected by the retailer's service-level commitment. The retailer can build service capacity in-house at a deterministic price before service demand is realized, or buy the service from an outsourcing market at an uncertain price after service demand realization. We find that the outsourcing market encourages the retailer to make a higher level of service commitment, while prompting the manufacturer to reduce the wholesale price, resulting in more demand realization. We analyze how the expected cost of the service in the outsourcing market and the retailer's risk attitude affect the decisions of both parties. We derive the conditions under which the retailer is willing to build service capacity in-house and under which it will buy the service from the outsourcing market. Moreover, we find that the manufacturer's sharing with the retailer the cost to build service capacity improves the profits of both parties.

1. Introduction

The products in many highly competitive industries have become homogeneous. To differentiate from competitors and to enhance competitive advantage, increasing numbers of companies bundle products with services (Bijvank, Koole, & Vis, 2010; Davies, 2004; Penttinen & Palmer, 2007). For example, Rolls-Royce provides airlines with "Power by the Hour", selling jet engines along with the services to maintain, repair, and upgrade them over many years (Davies, Brady, & Hobday, 2006). Lenovo sells personal computers and provides computer maintenance services to customers. In durable products markets, providing after-sales service like base warranty is not only a mandatory requirement by law, but also a means for firms to enhance their competitiveness.

The basic approach for manufacturers to provide after-sales service is to anchor in manufacturing and then move downstream to distribution, operation, maintenance, etc. through the life cycle of the product (Davies, 2004). At the beginning of service business development, many manufacturers reach service provision agreements with their retailers that the latter provide basic after-sales services, such as installation, repair, upgrade, and maintenance. For example, automobile manufacturers like GM, Toyota, and Volkswagen, reach agreements with their 4S (sale, spare parts, service, and survey) retailers that the latter assume the responsibility to provide after-sales service. Customers often take after-sales service for granted and regard it as part of the product offerings, for the fee of which is usually included in the retail price (Kranenburg & van Houtum, 2008). Keen to stimulate demand, retailers increasingly resort to service provision as a means to entice customers to buy products and stir up business (Lu, Tsao, & Charoensiriwath, 2011). Given the basic after-sales service of a product, customers tend to buy from the retailer that offers a higher level of service commitment. For example, Sunning and Gome, the number 1 and 2 home electronic appliance retailers in China, have made use of

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strong after-sales service commitments to compete for customers. To improve the sales of Haier (one of the global 500 companies) air conditioners, both of them offer cleaning service to customers for free while they sell the same model of air conditioners at the same price. Suning offers to clean customers' air conditioners at least once a year. However, it does not specify the response time. On the other hand, Gome pledges that its response time to a customer's request for air conditioner cleaning is no more than 72 hours.

To stimulate demand, the service-level commitment must be guaranteed: The higher the service levels retailers commit to customers, the greater the sales of their products. Retailers' *service-level commitments* would be believable either when customers are informed of the actual service levels or when they can make their own evaluations (Allon & Federgruen, 2009). On the retailer's side, the service-level commitment is a guarantee. The actual service level experienced by customers may sometimes be higher, but should never be lower, than the service-level commitment. On the manufacturer's side, in order to protect its brand reputation, a manufacturer usually asks its retailers to comply with their service-level commitments via contracts or penalizing retailers whose services fail to meet their commitments. Also, the manufacturer may employ third-party agencies to monitor its retailers' service levels. In this study we define service-level commitment as the reciprocal of the *average waiting time* for the service concerned. In other words, the higher the service-level commitment is, the shorter is the average waiting time for the service concerned, and vice versa. In many industries, the average waiting time is used as the primary advertised competitive instrument. For example, most automobile manufacturers, e.g., Volkswagen, Ford, and BMW, prominently feature the average waiting time for the car maintenance service per customer in their 4S retailers' stores and employ independent third-party agencies to monitor their retailers' service-level commitments.

To meet their commitments, retailers may build service capacity in-house or buy the service from an outsourcing market. The capacity built in-house is called *prior service capacity*, which should be ready for use before demand is realized. This is true for automobile 4S dealers, which have to build service capacity before the realization of customer demand. However, since demand has not yet been realized, a shortage or surplus of the service capacity might occur. Service outsourcing is a popular alternative for firms, which provides greater flexibility for retailers to fulfill their commitments. Therefore, researchers and practitioners face the question: "Should service capacity be provided in-house or should all or part of it be outsourced?" (Kosnik, Wong, Ji, & Hoover, 2006).

In this paper we address the issue of service capacity development for a retailer that sells products, as well as provides after-sales service, to customers. The retailer can either build its prior service capacity before demand is realized or buy the service from an outsourcing market after demand realization. A higher level of service commitment is related to more sales, but providing service could be costly (Fan, Kumar, & Whinston, 2009). What commitment should be made to consumers? Besides, given the uncertainty of service demand, how much service capacity should be built in-house and how much should be outsourced? Addressing these significant issues, we present a service capacity decision model for a supply chain involving a manufacturer and a retailer. The manufacturer offers a product to the retailer at a wholesale price, while the latter sells the product with after-sales service as a bundle to consumers. To fulfill its commitment, the retailer makes a decision on whether to build service capacity in-house or to outsource it.

We obtain four main results. First, the availability of a service outsourcing market motivates the retailer to make a higher service-level commitment. At the same time, the manufacturer is induced to reduce the wholesale price to stimulate the retailer to order more. Consequently, both parties are better off. However, if the expected price of the service in the outsourcing market is high, the service outsourcing market loses its appeal and all the decisions of the parties are the same as the case where no service outsourcing market exists. Second, when the retailer is risk averse, the retailer buys service capacity from the service outsourcing market if price volatility is low. Third, we propose a prior-service-capacity-cost sharing mechanism to improve the performance of the supply chain and both parties. Finally, we investigate the effect of the service outsourcing market on the manufacturer's wholesale price strategy. We find that there exists a critical point of the expected unit cost of the service capacity in the outsourcing market, caused by the manufacturer, beyond which the wholesale price is not continuous but sees a sudden jump, resulting in the retailer suffering a great loss. Therefore, the key for the manufacturer and the retailer is to identify the critical condition and make optimal decisions. It is crucial for the manufacturer to properly adjust the wholesale price under the critical condition. Specifically, when the expected unit cost of buying the service capacity from the outsourcing market is lower than the critical point, the manufacturer should reduce the wholesale price; on the other hand, it should raise the wholesale price. For the retailer, it should adjust its service-level commitment and order quantity in line with the manufacturer's wholesale price policy.

The remainder of this paper is organized as follows: In Section 2 we provide a brief review of the related literature. In Section 3 we introduce the notation and assumptions. We study the service capacity decision in the centralized supply chain and decentralized supply chain in Section 4, respectively. In Section 5 we consider the retailer's risk aversion to price volatility and its effects on the supply chain. We also propose a cost sharing mechanism to improve the performance of the supply chain and both parties. We provide numerical examples in Section 6 to further illustrate the analytical results. In Section 7 we summarize the results and suggest directions for future research. We put all the proofs and the main results in the Appendices.

2. Literature review

Increasing numbers of companies bundle products with services to differentiate themselves and to enhance competitive advantage (Bijvank et al., 2010; Davies, 2004; Penttinen & Palmer, 2007). Vandermerwe and Rada (1988) name this bundle as "servitization". Baines et al. (2007) use the concept of a product-service system (PSS) as a special case of servitization. A PSS can be thought of as a market proposition that extends the traditional functionality of a product by incorporating additional services. Johnson and Mena (2008) present a good literature review of bundling products with services.

In most of the inventory and operation management literature, the term "service" has a very specific meaning, which refers to the availability of products to satisfy stochastic demand. This is commonly labeled as *fill rate* (or probability of stockout) and has been incorporated as the primary metric of customer satisfaction in numerous models of single- and multiple-stage production systems (see, e.g., Cachon & Harker, 2002; Tsay & Agrawal, 2000; Bernstein & Federgruen, 2004). Thus, in the traditional operations management literature, "service" is mainly related to inventory, which is confined to the scope of products. This definition is too narrow to cover after-sales service that firms increasingly provide to customers nowadays. This kind of service has some salient characteristics that are different from those of physical products, such as intangibility and perishability, which determine the attributes of the corresponding service provision process.

By the way in which service is modeled, the literature on service system design falls into two streams. One stream uses a generic