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From competitive to collaborative supply networks: A simulation study

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ABSTRACT

In a scenario where a vendor books its manufacturing capacity options to multiple retailers it is not unlikely that the vendor runs out of capacity and then it cannot serve more orders until future periods of time. This paper suggests that, once the vendor becomes a bottleneck for the network, it is possible to apply negotiation policies between the different retailers to allow re-allocation of options and then overcome this loose/loose situation. Two simple policies to carry out bookings through negotiation practices, allowing partial bookings and not allowing them, are presented in this study. The effectiveness of this approach is tested with a series of simulation experiments whose main results demonstrate that application of negotiation practices within the network when the vendor has not more available capacity to be booked leads to improve the service level, the overall profit and to diminish the sales opportunity cost.

1. Introduction

Nowadays, it is not an unusual business practice that an enterprise not only sells its products/services to one or several buyers but also that such a producer allows manufacturing/service capacity bookings by its customers. These capacity bookings take place in advance and buyers, by paying a certain price, get the option of exercising them in the future. Decisions about how much from the available capacity should be offered to the market and both booking and exercising prices have been intensively discussed [1–3]. In this context, an enterprise might fix, for a certain period of time, a determined and constant amount of capacity to be booked, which may turn out to be insufficient to meet the demand. Such a demand is not known in advance and lumpy in many occasions [4], which make capacity booking decisions even more difficult to be taken. Collaborative and co-operation relationships, especially those regarding supply chain information sharing between the vendor and the retailers do help to overcome these problems [4–6]. There are many supply chain co-ordination frameworks in the literature. Li and Wang [7] carried out a review of co-ordination mechanisms of supply chain, stating that the main decentralized models can be classified into deterministic and stochastic ones. The former can be also broken down into quantity discount models [8–10] and profit-sharing models [11,12]. On the other hand, the main stochastic models are the so-called game models. Among these game theory models, Cachon [13] developed a Nash equilibrium solution to select inventory policies in a two echelons supply chain with one supplier and N retailers. Esmaeili et al. [14] model the relationships between seller and buyer following both non-cooperative and cooperative games. The non-cooperative game was

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based on the Stackelberg model considering separately the case when the seller is the leader (Seller-Stackelberg) and also when the buyer is the leader (Buyer-Stackelberg). Cai et al. [15] studied how advanced strategies affect the interactions between the supply chain members, considering multiple buyers by introducing a demand function under uncertainty. Zhao et al. [16], Bauso et al. [17], Yang and Zhou [18] and Nagarajan [19] also developed game theory models applied to one single supply chain in order to improve co-ordination activities within the supply chain. From a supply chain optimization point of view, Silva et al. [20] developed a supply chain ant colony optimization for modeling supply chain distributed actors. All the developed supply chain co-ordination frameworks aim to improve the whole supply chain performance and, extensively, the individual members' one. However, most of these frameworks were developed to be applied to one single supply chain dealing with win/win relationships. However, there is a special scenario that goes beyond this *win/win* supply chain/network relationships and that, initially, it is far more difficult to handle. This scenario is characterized by the situation when there are several supply chains competing for limited resources supplied from the same vendor, who therefore forms part of all these different supply chains at the same time. In this particular case, the relationships established between the different retailers are of a *win/lost* nature, as the common vendor has got limited capacity to be booked. If the vendor runs out of manufacturing capacity it becomes a bottleneck that automatically rejects all further order bookings it receives. This would be a *lose/lose* situation for both the vendor and the retailers, as the former assumes an opportunity cost and the latter has to wait until the next period of time when the vendor will have again available capacity to be booked. In this point, the situation could drift away to become an indirect *win/win* one, with the vendor playing a broker role with the different retailers, trying to re-allocate capacity already booked to others vendors of the network to serve an actual order. Then, if the vendor succeeds in such a negotiation process, a money transfer will be made from the buyer–retailer to the seller–retailer passing through the vendor, who will get a commission of the price paid from the buyer–retailer to the seller–retailer for giving up its booked options.

It is important to point out that such a negotiation process takes place before the real demand occurs and that this paper will deal only with booking options and not considering the case when the real demand is known and then the retailers may want to exercise their options. Then, the results of the study pretend to provide some light to the task of whether negotiation process in this context, before the demand is known and decisions to be made under a higher degree of uncertainty, will outcome higher profits for both the vendor and the overall network or not.

Fig. 1 illustrates the vendor–retailers relationships lifecycle in function of the vendor's amount of available capacity and the vendor's/network overall profit. The following three main trams regarding the type of relationship between the vendor and the retailers can be identified (see Fig. 1):

A. *Win/win* relationship. The vendor's/network overall profit increases while there is enough capacity to be booked by the different retailers. In this case, the retailers pay to the vendor for booking its capacity.
B. *Lose/lose* relationship. When the vendor has booked all its available capacity to the different retailers the vendor's/network overall profit decreases to zero.
C. *Indirect win/win* relationship. The vendor's/network overall profit increases as a consequence of capacity re-allocation activities through negotiation processes between retailers and managed by the vendor. In this situation, the vendor makes certain profit as a consequence of playing the broker role and, similarly, there is a transfer of money between the different retailers that results in an increment of the vendor's/network overall profit.

Fig. 1 is illustrative and it aims to provide a graphical overview of the relationships that take place in this network and to situate the point where, depending of whether negotiation processes take place between the vendor and some retailers or not, the vendor's/network overall profit will increase or not. Such a point is represented in Fig. 1 with the name of "decision point".

Then, from such a "decision point", if negotiations processes take place and capacity relocation is made, then the situation represented in Fig. 1 by C will come up; otherwise, the situation represented by B is achieved.

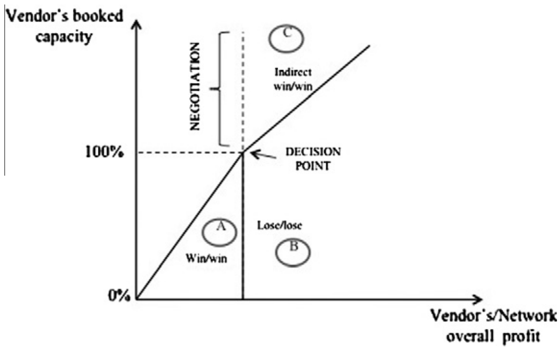

Fig. 1. Vendor–retailers relationships life cycle.