

## **Bilateral Bargaining and Outsourcing Strategies in a Three-Tier Supply Chain**

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In today's global economy, outsourcing production activities to the third-party contract manufacturers (CMs) has become a prominent practice in many companies. Along with production outsourcing to the third party CMs, the OEMs also need to consider another important issue, that is, component procurement. Should the OEM authorize the CMs to purchase the required materials on its behalf or do it by itself? If yes, then the OEM is unable to contract directly with the supplier. In reality, the OEM and the CM may demonstrate different bargaining powers over the supplier. Consequently, who to bargain/contract with (multilateral bargaining structure) and the sequence of contracting/bargaining among the supply chain parties will directly affect the outcome of the procurement prices and thus the supply chain performance. Also, when shall an order be placed, before demand realization or after it? Answers to the aforementioned two questions affect both the procurement price and the supply risk (or inventory availability), which are two critical factors influencing the OEM's outsourcing decision (Amaral et al. 2006). In this paper, we aim to study the impacts on price negotiation and supply risk (inventory availability) of different bargaining sequence and procurement structures. For the sake of simplicity, we consider a serial three-tier supply chain consisting of an OEM, a CM and a supplier, and assume that the OEM outsources all manufacturing functions to the CM.

There are two outsourcing structures, control and delegation. In the former case, the OEM retains the component procurement function in-house; in the latter case, the CM is responsible for both manufacturing and component procurement. We also consider two types of contracts on ordering timing, push and pull.

*Push:* The quantity-order decision takes place before demand realization. There is no at-once order after demand realization.

*Pull:* The quantity-order decision occurs after demand realization. The CM and the supplier need to invest in specific capacities or commit resources in advance.

In total, there are four procurement strategies according to the combination of the above outsourcing structures and the timing of order arrangements: Control+push, control+pull, delegation+push and delegation+pull. Those different combinations affect the inventory risk allocation among supply chain parties, which affects the CM's and the supplier's capacity setting-up and leads to different levels of supply risk. Under delegation, it is the CM who takes

the ownership of the component inventory whereas it is the OEM under control structure. And ordering before demand realization shifts the inventory/capacity risk downwards along the supply chain while ordering after demand realization shifts it upwards.

To obtain some insights on which procurement strategy the OEM shall adopt and under what conditions, we take a comprehensive modeling approach on price negotiation and capacity decisions. To model the wholesale-price negotiation among the OEM, the CM and the supplier, we consider the cooperative *generalized Nash bargaining* (GNB) game. The GNB scheme provides a unique bargaining solution that maximizes the joint surplus of two negotiation agents. In a multi-tier supply chain network, the production capacity, and hence the whole supply chain profit, is jointly decided by the supply chain parties; that is, production activities are *multilateral*. Nevertheless, the supply chain parties usually negotiate on the supply chain contract *pairwisely* or *bilaterally*. Therefore, the profit may be maximized locally through bilateral GNB but not globally. An important issue is to evaluate the loss of the total surplus and the final distribution of this surplus among all parties associated with the bilateral bargaining in a three-tier supply chain. In particular, we aim to understand the impacts of the structures of bargaining network (who can bargain with whom) and, under a certain network, the *sequence* of these pairwise bargaining.

Below we will introduce some typical bargaining structures and sequences that can be adopted in control and delegation outsourcing structures. When a control outsourcing structure is adopted, there exist three wholesale price negotiation sequences that the supply chain parties can engage in. They are defined as follows. (1) Control Sequence 1: the OEM and the CM negotiate first, then the OEM and the supplier negotiate; (2) Control Sequence 2: the OEM negotiates with the CM and the supplier simultaneously; and (3) Control Sequence 3: the OEM and the supplier negotiate first, then the OEM and the CM negotiate. See Figure 1 for the illustration.

When a delegation outsourcing structure is adopted, there also exist three wholesale price negotiation sequences that the supply chain parties can engage in. They are defined as follows. (1) Delegation Sequence 1: the CM and the OEM negotiate first, and then the CM and the supplier negotiate; (2) Delegation Sequence 2: the CM negotiates with the OEM and the supplier

simultaneously; and (3) Delegation Sequence 3: The CM and the supplier negotiate first, and then the CM and the OEM negotiate. See Figure 2 for the illustration.

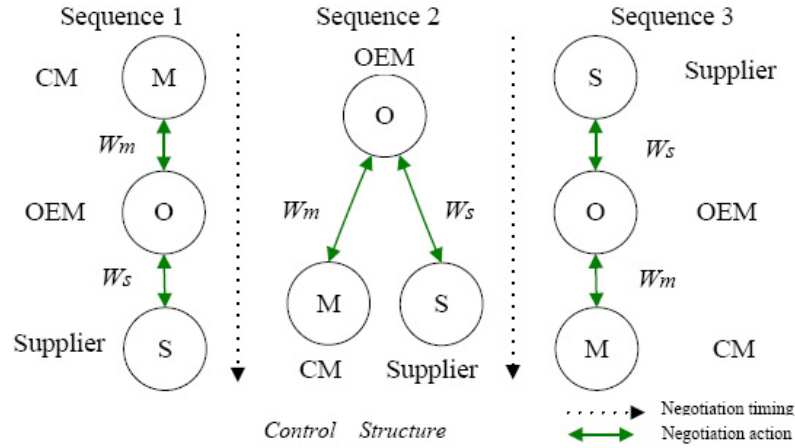


Figure 1: Three Negotiation Sequences under Control

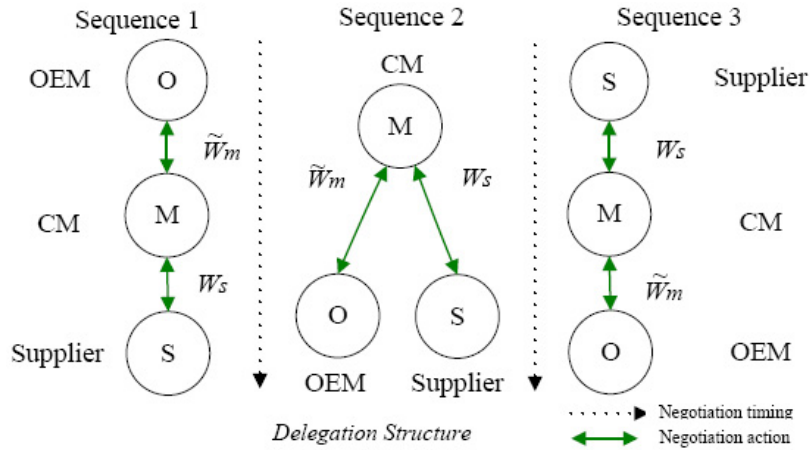


Figure 2: Three Negotiation Sequences under Delegation

As to the capacity decisions of the CM and the supplier, we model them as a newsvendor type problem, where the CM and the supplier need to invest in specific capacities before demand realization, such as special equipment, raw materials purchasing and worker training. Moreover, when the CM (supplier) makes a capacity decision, it also has to take the supplier's (CM's) capacity decision into consideration, as the whole supply chain's capacity is jointly determined

by the two parties. For the combination of procurement scenarios and the aforementioned pairwise bargaining sequences, we derive the GNB-induced wholesale prices and equilibrium capacity decisions. We find that the final triad distribution of the whole profit among the three parties is affected by bargaining structure, bargaining sequence and the timing of bargaining. The important managerial insight generated from our paper is that in a multi-tier outsourcing supply chain, wholesale pricing, capacity building and profit allocation are not only affected by the contracting structure but also affected by the contracting sequence. So the answers to questions “who bargains with whom” and “when to bargain” affect the effective surplus allocation among the supply chain agents and thus affect the outsourcing structure selection.

#### References

Amaral, J, Billington, C., and Tsay, A., 2006. Safeguarding the promise of production outsourcing. *Interfaces*, 36, 220-233.