Graduate Program in Industrial Engineering

Capacity Games in Decentralized Assembly Systems with Uncertain Demand

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Abstract: Consider an assembler who needs sets of components each produced by a different supplier. The final product has a short selling season with uncertain demand. In order to produce the components and assemble the final product, firms involved need to first build up their individual production capacities. Due to a long lead-time, capacity decisions have to be made well before the selling season starts or before observing the demand realization. Once the capacity is in place, however, production itself requires very little time, and thus the decision on production quantity can be delayed until demand uncertainty is resolved. Unutilized capacity has a salvage value, and in the event of shortages, some or all of the firms may have more expensive second source capacities to use.

The firms have an incentive scheme (contract) to induce a "proper" capacity build-up. The key parameters of the contract are a set of *transfer prices* the assembler pays each supplier for a unit of its component. We consider two scenarios as for how the terms of the contract are determined and study their corresponding equilibrium capacity decisions. The first is one where the assembler sets up the transfer prices. We call the resulting problem the assembler-as-leader capacity game. The second scenario is for the suppliers to simultaneously choose the prices each wants to charge. We call it the suppliers-as-leaders capacity game.

We first characterize the optimal capacity decision when the system is centralized, and then derive the decentralized equilibrium system capacity under each of the two game settings. We show that the decentralized channel performances depend heavily on system structure/parameters. In particular, when there is no second source capacity available, under the assembler-as-leader game, the performance improves as the assembler's share of the system-wide unit capacity cost increases and it does not change with the number of suppliers in the system. Under the suppliers-as-leaders game, on the other hand, the performance degrades both in the assembler's share of capacity cost and in the number of suppliers. We show that an assembler-as-leader game dominates a suppliers-as-leaders game, in terms of system performance, if and only if the assembler's share of capacity cost is larger than the reciprocal of the number of firms involved. Lastly, we develop a simple mechanism to achieve channel coordination and arbitrary allocation of channel profits among the firms. The mechanism requires that either the assembler pay the suppliers, or the suppliers each pay the assembler, a subsidy for unutilized capacity.

Hosted by: Professor Diwakar Gupta, (612) 625-1810, guptad@me.umn.edu.

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