

Coordinating capacity investments with joint ventures

Philippe Chevalier¹, Guillaume Roels², Ying Wei¹

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Extended abstract

Joint venture problems are difficult because investment and operational decisions are linked together and need to be coherent. On the one hand, the operational decisions are constrained by the investment decisions; on the other hand, the operational decisions will influence the investment decisions in the sense that the attractiveness of the investment depends how operational decisions are expected to be made.

In this paper, we study joint ventures as a two-stage decision problem from the decentralized perspective: during the first stage the partners invest in common production capacities and during the second stage the facility is used to satisfy the demand of the partners given the capacity constraints linked to the investment decisions. The research question is to find efficient contracts that coordinate (i) the joint investment decisions and (ii) the product mix decisions.

We are aiming at finding contracts which are easy to enforce, and efficient in their use of the capacity investment (in terms of system-optimal production level giving the capacity constraint). We are also interested in checking the incentive compatibility of the different players.

Starting with a simple setting where there are two partners that invest jointly in a flexible production capacity, and then use this capacity to satisfy the uncertain demand on their respective markets. The players first decide on their respective investments in order to build the facility. The capacity is used in such a way as to maximize the value of the production given the realized demand. This implies that the capacity is used in priority to satisfy the demand having the larger operating margin.

We analyze different existing contracts with respect to individual-rationality and incentive compatibility: (1) profit sharing contract where the profits is arbitrarily allocated, similar to Cachon and Lariviere (2005), Wei and Choi (2009); (2) ex-post revenue sharing contracts, see Van Mieghem (1999); (3) ex-ante transfer price contract similar to Rudi et al. (2001); and (4) state-dependent transfer prices, similar to Van Mieghem's state-dependent transfer prices (1999).

¹Université catholique de Louvain, CORE, B-1348 Louvain-la-Neuve, Belgium.

²Anderson School of Management, University of California at Los Angeles, Los Angeles, California 90095, U.S.

Specifically, we propose a capacity leasing contract which work as follows: in the first period each player invests one part of the linear investment cost; based on the global investment and on the distribution of the demand a leasing fee is fixed per unit of capacity used. In the second period the demand for each player's products is revealed, the global profit maximizing production plan is carried out and each player pays the fixed leasing fee for each unit of capacity used for its own products; each player collects the revenues of its own sales; at the end of the second period the leasing fees are redistributed according to the investment shares of the capacity. We find that if the joint demand density function satisfies certain properties, there exists a pure-strategy Nash equilibrium in the capacity investment game under a capacity-leasing contract. To reach this we fix the leasing fees to the ratio of the investment cost divided by the expected utilization rate of the capacity, with this value the expected amount of the total leasing fees matches exactly the investment cost. In addition, it is possible to show that the Nash equilibrium is unique. We also find that the game is dominance solvable, implying Cournot stability. That is, for any fixed leasing price, the corresponding Nash equilibrium can be found through a sequential tatônnement process, in which the players alternate in making propositions.

By sensitivity analysis, we find that the optimal leasing price is increasing with the variance of the joint demand. The capacity leasing contract also applies to multiple products-multiple resources-multiple players in a newsvendor network, however, the convergence of the tatônnement process is lost.

The drawback of the fixed fee leasing contract is that when demand is revealed the players do not have a common incentive to carry out the global profit maximizing production plan. To address this, we study a differentiated leasing price scheme where the leasing fee is different for different players. We identify the necessary and sufficient conditions under which the individual rationality (in the weak sense) and incentive compatibility can be satisfied simultaneously. We also show the existence of a Nash equilibrium under certain conditions.

References

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