INFRASTRUCTURE SHARING SYNERGIES: STRATEGIC CAPACITY SETTING UNDER UNCERTAINTY

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Overview

Sustainable production of energy and input materials can be notably achieved by cross organizational cooperation based on business to business economic exchanges so called as Industrial symbiosis (I.S). The two forms of I.S practices are infrastructure/service sharing and resource substitution (the use of waste materials, fatal energy and recirculated utilities for production). While the latter consists in the alternative use of an under valued resource the former proposes the intensification of use of an asset in order to gain on capital expenditutres. For such cooperative practice to be worthwhile the incremental investment cost is required to be lower than the standalone cost faced by each potential participant to satisfy its own requirements.

We study the way such a cooperation mode can be implemented by formulating a game theoretic model integrating the ex-post access pricing problem with the ex-ante grassroot investment decision. An entrant whose capacity requirement is randomly distributed and known only after investments are done in a first period is offered a contract (tariff, available capacity) in a second period. Two actors (initial investors in capacity) set cooperatively (resp. non-cooperatively) a level of common (resp. individual) infrastructure capacity oversizing. En-ante capacity value is related to the entrant's (ex-post) willingness-to-pay for the access to the infrastructure. This WTP is driven by two cost factors that are her standalone cost and the complement cost to be incurred if the available capacity is lower than her actual requirement level (due to back-up expanses). Profitable overcapacity setting is then made possible by the capacity setting cost function exhibiting sub-additive property following engineering economics arguments.

Methods

To address the strategic decision making part of the problem non-cooperative and cooperative game theory reasionings are applied. In order to tackle the embedded capacity optimization under uncertainty problem standard tools of convex optimization are used provided demonstration of their applicability.

Results

First the expected complement cost function is derived and we show that it is decreasing, convex and shaped by the entrant's requirements distribution function. Using Laplace criterion (Expected cost minimization with uniform distribution) optimal capacity level is obtained in the cooperative setting and equilibrium levels are determined in the non-cooperative case. Regarding the latter we show that in the case of competition between first investors (no cooperation case) three equilibria can occur depending on the problem parameters specification.

Conclusions

Using the non-cooperative game outcomes which gives lower bounds for the profit sharing problem in the cooperative one we solve the whole game and describe situations supporting sharing agreements. If cooperation is impossible (technical or geographical constraints) inefficiencies can occur. Otherwise global ex-ante optimality is ensured providing bounds on incumbents contributions related to the non-cooperative equilibrium outcomes.