R&D Investments under Endogenous Cluster Formation

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Extended Abstract

Joint cooperative activities among firms, particularly with respect to R&D, are important features of many industries and influence profitability and technological innovation (see e.g. Hagedoorn, 2002; Powell et al., 2005; Roijakkers and Hagedoorn, 2006). Examples of R&D cooperation include the formation of research joint ventures or clusters, the exchange of information, and the share of laboratories or facilities. In many cases, the firms cooperating on the R&D level are competitors in the market, which gives rise to intricate strategic considerations when selecting R&D partners, or deciding on the investments in R&D. Several trade-offs have to be considered: joining a consortium of firms allows a given firm to access the spillovers generated by R&D while it also embodies a contribution to joint activities which benefit and strengthen the competitors. Investments in R&D are decided on the individual firm level which gives incentives to free-ride on others’ investments. However, investing low in R&D may leave a firm as a very unattractive partner outside of a research cluster. Hence, by determining the investments in R&D and joining a consortium, a firm faces the trade-off between attracting partners and free-riding on others’ effort.

We study investment decisions in R&D and the formation of collaboration clusters as a three stage game. Since investments in laboratories, facilities, or R&D departments are rather long-term decisions, and partner and market decisions can adjust more flexibly, firms decide on these R&D investments in the first stage. After learning each others’ R&D efforts, firms then form R&D joint ventures in the second stage which induces a partition of firms into R&D clusters. The process of group formation is modeled by the coalition formation game introduced in Bloch (1995), also called the unanimity game. We assume that collaborative activities of the resulting R&D clusters lead to process innovation which lowers marginal costs of producing a homogeneous good. After learning the marginal costs, firms then compete on the market by selecting quantities in the third stage.

Given the investment decisions in R&D of the first stage, we find that any equilibrium of the second stage gives rise to the same coalition structure (up to permutation of symmetric firms). If investment in the first stage is a binary decision, then the equilibria of the second stage result in the formation of two respectively three R&D consortia, depending on the differences in R&D expenditures. If these differences are small, then only two groups form, which makes analysis of the first stage tractable, giving rise to a closed form solution of the subgame perfect equilibria in pure strategies of the complete game. We find that depending on the costs of R&D efforts, there can be multiple subgame perfect equilibria. For large enough costs of R&D, either no firm chooses high investments or there exists a unique number of firms choosing high investments. The number of investing firms in the latter equilibrium is decreasing in investment costs, while the no-investment equilibrium vanishes if these costs are low enough. By comparing investments in R&D to the case where coalitions are exogenously given, we are in a position to determine the effects of the additional incentives to invest which arise through the coalition formation stage. Overinvesting as a strategic device to attract partners for R&D can even lead to the case where all firms invest high for a cost range where no firm would invest under exogenously given groups. Hence, the formation of collaboration structures in games of long-term R&D investments clearly has positive effects on consumer surplus.

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By focusing on these long-term investments in R&D and modeling this as the first stage, we are, hence, able to provide a complete characterization of a model of endogeneous R&D efforts and endongeneous group formation. In similar models in the literature, only incomplete characterizations arise since those models cannot be solved analytically. One example is the model of Greenlee (2005) which is similar to our framework except that the first and second stage of the game are reversed, giving investment decisions a rather flexible than a long–term interpretation. However, in such a model, it is impossible to characterize the resulting coalition structures. The same is true when R&D joint ventures are restricted to bilateral (non-exclusive) cooperations, i.e. focusing on R&D networks as the first stage while investments are endogeneous in the second stage (see e.g. Goyal and Moraga-Gonzalez, 2001; Goyal et al., 2008). Only for exogenous and homogeneous investments, characterizations of group formation (Bloch, 1995) and network formation (Goyal and Joshi, 2003; Dawid and Hellmann, 2014) have been provided. Moreover, to the literature on group formation when investments are exogeneous (Bloch, 1995; Yi, 1998), we also contribute by analyzing the case of heterogeneous investments since these are taken as given in the second stage.

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**References**


