The Welfare Effects of Research and Production Joint Ventures

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ABSTRACT. This paper develops a model to analyze behavior and welfare effects of a research and production joint venture (JV). In the model, a research dollar is more productive if spent in the joint venture because it increases the achievable probability of new product introduction. This efficiency of research and production joint ventures offsets, to some degree, the loss due to higher consumer prices. For some parameter configurations and joint venture membership rules, research and production joint ventures yield higher social welfare than research-only joint ventures (RJVs). This contrasts with some of the industrial organization literature on research collaboration and with traditional antitrust views.

Key words: R&D, research joint venture, social rate of return, welfare analysis, innovation, game theory

JEL Classification: O33

1. Introduction

Mansfield *et al.* (1977) laid out a pioneering methodology for the estimation of private and social returns from industrial innovations. The methodology identified the following factors as critical: (1) whether the innovation is a product innovation used by households, a product innovation used by firms, or a process innovation; (2) the cost and timing of unsuccessful or discontinued parallel research efforts by other firms. In his consideration of the latter factor, Mansfield acknowledges the inherent uncertainty of R&D outcomes. Yet in much recent theoretical modeling of R&D, and especially modeling of research joint ventures, this uncertainty is omitted.[1] One of the main purposes of this paper is to examine the effects of uncertainty on behavior of research and production joint ventures (JVs). Here, the uncertainty of R&D coupled with product innovation leads to welfare conclusions that contrast with some of the industrial organization literature on cooperative R&D and with traditional antitrust views. Under some circumstances, research and production joint ventures frequently outperform research-only joint ventures (RJVs) in terms of social welfare. In retrospect, Mansfield's emphasis on the details of the R&D process and its outcomes seems all the wiser.

This paper develops a model to investigate research joint venture formation when venture participants are free to cooperate in output production as well as research activity. The model is an extension of Combs (1993). In the model, endogenously formed research joint ventures and venture non-participants aim to develop and introduce new products to households. In the event that the multiple entities produce innovations (e.g. the joint venture and one or more non-participants), they compete against each other in a homogeneous product market. In other words, patent protection is ineffective.

The benefits and the opportunity costs of joining the venture are tied to the randomness of R&D outcomes. The benefits of joining are improved efficiencies of R&D stemming from a higher achievable probability of success of innovation. The cost of joining is the foregone opportunity to become a monopolist—rather than share joint venture profits—in the event that others fail to innovate. However, the opportunity cost shrinks as the joint venture grows. This occurs because a larger joint venture is more

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likely to successfully develop the new product due to increased R&D efficiencies and increased spending on R&D. It should be noted that in practice, technology spillovers might also figure into the benefit of collaboration. However, this model does not consider such spillovers, so as to focus on the benefits of efficiencies related to the uncertainty of R&D.

The social benefits and costs of allowing such a joint venture to operate also stem in part from the randomness of R&D outcomes. The social benefits of the joint venture accrue from the value to the consumer of new products that are more likely to be introduced if the joint venture forms. However, the joint venture's cooperatively set output levels result in higher prices, ex post, which present a social cost.

The paper compares expected total surplus across three regimes: Regime A—cooperation in both research and production levels; Regime B—research-only cooperation with free entry to the joint venture, as examined in Combs (1993); Regime C—research-only cooperation where the joint venture is allowed to block entry, as examined in Combs (1993). Research and production ventures with entry blocking are not included in the comparison because entry blocking is not binding in equilibrium.

In Regime A, all firms join the joint venture. This formation resembles an industry-wide merger. In the grand joint venture, the industry research level is maximized due to maximum research efficiency leading to highest R&D incentives. In turn, this maximizes the probability of new product introduction. For most parameter values, expected consumer surplus is maximized. For all parameter values, both expected industry producer surplus and expected total surplus are maximized.

Comparing Regime A to the two other regimes, the results are mixed. When parameters are set to yield a low inherent probability of success, Regime A has greater expected total surplus than Regime B, because in Regime B, not many firms enter the joint venture due to low incentives, so efficiencies are not exploited. Otherwise, Regime B outperforms A, because R&D cooperation and efficiencies are maximized, and competition in the output market keeps prices low. In contrast, Regime A always outperforms C. Entry blocking will be profitable for the joint venture in Regime C, so its joint venture is small and efficiencies will be minimal, yielding a lower probability of industry innovation.

Related literature

The somewhat favorable welfare impacts of research and production cartels found here run counter to some of the cooperative R&D literature. For example, Hinloopen (2000) and Bloch (1995) find that research joint ventures always reduce welfare if collusion in the product market is allowed. But general discussions have recognized the tradeoffs between efficiencies of cooperative R&D and potential higher product prices. See, for example, Jorde and Teece (1990), Brodley (1990), Shapiro and Willig (1990), and Grossman and Shapiro (1986). Some formal models of cooperative R&D, including Ordover and Willig (1985), D' Aspremont and Jacquemin (1988), Kamien *et al.* (1992), Poyago-Theotoky (1997), and De Fraja and Silipo (2002) suggest that extending collaboration to the product market may improve welfare, although under restricted conditions.[2]

The model with results most similar to this paper is De Fraja and Silipo (2002), who incorporate uncertainty of R&D and product market innovation. They also incorporate technological spillovers, which are omitted in this paper. Although their model uses a different framework, they also conclude that the research and production cartel sometimes outperforms the research-only joint venture. The rationale is identical to the model here—firms spend more on R&D if they can reap more profits in the product market; this increases the probability of success in R&D which can help to benefit consumers. Poyago-Theotoky (1997) derives similar conclusions. Also using an alternative framework, she examines market outcomes for a three-firm industry that engages in cooperative research aimed at uncertain product market innovation. In her paper, if a "superproduct", developed and priced cooperatively, raises quality high enough, then welfare improves. This paper reinforces the above findings but does so with more generality in the number of potential collaborators. With n potential collaborators, richer scenarios are examined with respect to