Innovation Races with the Possibility of Failure

BACKGROUND

- Uncertainty is an intrinsic characteristic of the innovation process. An R&D project may fail technologically, and it may succeed from an engineering or scientific point of view but fail commercially. Some approaches to achieving a research goal will be more promising, some less, and it will be uncertain which is which.

- The typical innovation race model examines a cost-saving innovation of known magnitude, with an expected time of completion related to R&D expenditures in a known way and with a random time to discovery distributed in such a way that eventually an R&D project must succeed.

METHODOLOGY

- The authors examine the extent to which R&D cooperation can be expected to promote innovation in the presence of uncertainty if one relaxes that aspect of the standard specification which implies that eventual success of an R&D project is certain.

- The possibility of project failure is introduced by making 'completion of the project' a lottery:
    - with probability p, an R&D project succeeds, and the aftermath is as in the standard innovation race model;
    - with probability $1-p$, an R&D project fails, and the firm has the option of starting a new project.

- Within this framework, the authors compare monopoly, duopoly, and R&D joint venture incentives to invest in R&D.

KEY FINDINGS

- If the probabilities of successive research projects are independently and identically distributed, eventual success of some project is certain, although any one project may fail.

- Monopoly innovation effort rises with the probability of success and the magnitude of the reduction in cost that follows from successful innovation.

- Duopoly R&D efforts are strategic complements, and equilibrium R&D efforts, like monopoly R&D effort, rise with the probability of success.

- Equilibrium duopoly R&D effort exceeds equilibrium monopoly R&D effort, all else equal, and equilibrium monopoly R&D effort exceeds equilibrium R&D effort of an R&D joint venture.

- However, a joint venture will find R&D profitable at higher levels of sunk cost per project than will either monopoly or duopoly.

- When the basic model is extended to allow multiple R&D projects per firm, monopoly and joint venture R&D intensity per project rises, and the number of R&D projects falls, as the probability of success rises.

- As the probability of success of an individual project rises, the number of R&D projects per firm in non-cooperative duopoly rises, as does R&D intensity per project.

- Equilibrium R&D effort per firm is least with an R&D joint venture.

- Monopoly R&D yields the least consumer surplus, while a joint venture yields the most consumer surplus and net welfare gain.

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