

### ***Oligopolistic cooperation in environmental R&D with no commitment***

We revisit the debate on firms' incentives to invest in environmental R&D in an oligopoly market where firms choose abatement levels and outputs simultaneously, i.e., with no commitment to R&D levels. The firms engage in abatement R&D in response to exogenous emission taxation by a government. In addition to the non-cooperative scenario for R&D, we investigate a cooperative research scenario for firms in the presence of R&D spillovers. Specifically, we distinguish three forms of firms' cooperation: the non-cooperative scenario, the semi-cartel, and the cartelized research joint venture. Whereas in the non-cooperative scenario firms choose environmental R&D levels and outputs with the purpose of maximizing their individual profits, in the semi-cartel firms join their R&D efforts but compete in output. The cartelized research joint venture is a special case of the semi-cartel with the R&D spillover parameter equal to one. We find that the cartelized joint venture provides the largest incentives to innovate, maximizing the levels of output and social surplus. In contrast, the incentives for R&D and output are minimized under the non-cooperative scenario. More interestingly, we establish that the effects of cooperative R&D are independent of the magnitude of the technological spillover. Thus, our findings suggest that without commitment, the usual trade-off between emission tax policy and cooperative R&D is absent. The results highlight important differences between the no-commitment case and the commitment case for environmental R&D.