

On the one hand, firms prefer to perform R&D in an open mode (letting R&D be performed extramurally or even selling their R&D services) to benefit from knowledge spillovers and complementarities between internal and external R&D. On the other hand, they like to perform R&D in a closed mode (funding and executing their R&D internally) to minimize outgoing externalities. We examine the dynamic process by which firms change the way of doing R&D and how these strategic choices affect their productivity growth. This study is based on the Statistics Canada Research and Development in Canadian Industry survey (RDCI), which collects data on R&D performed in the business sector in Canada. The paper uses data for the period 1997 to 2006. The panel dimension of the data allows controlling for unobserved characteristics of R&D performers by estimating a multinomial Logit model with unobserved heterogeneities using a maximum simulated likelihood (MSL) method.

Our analysis shows two important facts. First, there is a high degree of persistence in the way of doing R&D at the firm-level, in particular for domestic continuous R&D performers. Thus, opting for a given strategy in the first period increases significantly the probability of keeping to that same strategy in the next period. This persistence is evaluated at 42% for firms that operate in a closed R&D mode, 50% for those that operate in a make-buy mode, 34% for firms that operate in the make-buy-sell mode and 20% for those that operate in make-sell mode. Thus the way of doing R&D is very much path-

dependent. Second, the evolution of R&D behavior is towards increased specialization with internal and external knowledge sourcing and transfer of R&D services to outsiders. This phenomenon is even more pronounced in foreign controlled firms. The analysis also reveals a positive correlation in the different ways of doing open R&D through the individual effects and the importance of controlling for those individual effects in the error terms.

Regarding the effect of the mode of doing R&D on productivity, we confirm previous studies in the literature that point to a complementarity between internal and external R&D. We also confirm that the returns to R&D are significantly higher for firms that are continuous as opposed to occasional R&D performers and for firms that do radical R&D, whatever the mode of doing R&D that is adopted.

To our knowledge this is the first study in the Canadian context that examines the transitional dynamics in the organization of R&D and its implications in terms of economic performance using firm panel data and quantitative measures of the ways of doing R&D. One of the main limitations is the absence of capital stocks in the measurement of productivity. A promising direction for further research would be to take into account the attrition issue and to allow for a higher order Markov process.

The full study is available on CIRANO's Website at:

<http://www.cirano.qc.ca/pdf/publication/2013s-42.pdf>