



Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance

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ABSTRACT

To cope with fast-changing business environments, firms are increasingly opening up their organizational boundaries to tap into external source of knowledge. By restructuring their R&D system, firms face the challenge of balancing internal and external R&D activities to profit from external knowledge. This paper examines the influence of R&D configuration on innovative performance and the moderating role of a firm's R&D capacity.

The findings suggest that firms that increasingly rely on external R&D activities have a better innovative performance, yet up to a point. Beyond this threshold, a greater share of external R&D activities reduces a firm's innovative performance. And such substitution effect is larger for firms with greater R&D capacity. Overall, this paper provides a better understanding of the open innovation paradigm by suggesting that the opportunity cost for further opening up R&D borders is higher for firms with a superior technological knowledge stock.

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1. Introduction

Over the past years firms have increasingly relied on external sources of knowledge in their R&D processes to develop and profit from innovations (Calantone and Stanko, 2007; Linder et al., 2003). The conventional paradigm of having organizational core R&D activities exclusively in-house is becoming less critical, while more recent models of innovation suggest how firms are 'opening' up their R&D borders to tap into external sources of knowledge (Chesbrough, 2003). Tapping into external technology sourcing alleviates some of the challenges firms face such as shorter product life cycles, faster product renewal and increasing R&D costs (Rigby and Zook, 2002). On the other hand, searching for and coordinating an increasing number of new collaborations are activities that require greater investments in time and money. Consequently, higher transaction costs may erode the benefits of new external R&D activities. As firms start to systematically open up their R&D borders, they adapt and fine-tune their R&D configuration – their internal and external R&D processes – to build new or reinforce existing relationships with a diverse range of partners. Given the importance of R&D processes, the difficult task for managers is to find a balance between internal and external R&D activities in order to capture the benefit from external technology sources.

This paper addresses this issue by investigating how the trade-off between internal and external R&D processes influences a firm's innovative performance. In particular, it focuses on how a firm's internal R&D capacity – internal R&D investment in building stock of knowledge – moderates the relationship between a firm's R&D structure and its innovative performance. Prior research suggests firms can tap more efficiently into external sources of knowledge by investing in own R&D. Firms that invest in building an internal R&D stock of knowledge are better able to recognize and evaluate external sources and in turn to integrate and use their knowledge (Cohen and Levinthal, 1990). Moreover, they often rely on fewer yet more valuable linkages to achieve greater innovative output (Arora and Gambardella, 1994). Since selection and assimilation of external knowledge depend on a firm's stock of knowledge (Cohen and Levinthal, 1990), it is relevant to know how internal R&D capacity influences the relationship between the degree of R&D outsourcing and innovation performance.

By investigating the moderating role of R&D capacity in balancing internal and external R&D activities, this paper explores the conditions in which the open innovation paradigm matters for greater innovative performance. By doing so, it contributes to the literature in two ways. First, by building on a study by Cassiman and Veugelers (2006), this paper tests the extent to which internal and external R&D activities are complementary or substitute for greater innovative performance. Whereas Cassiman and Veugelers (2006) investigate how each of the distinctive R&D structures (Make, Buy and Make & Buy) influences innovation performance (using

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essentially three models with three dichotomous variables), this paper focuses on the degree of R&D outsourcing. By using a continuous approach to the Cassiman and Veugelers' typology, this paper provides a better understanding of the benefits and drawbacks in opening up a firm's R&D borders and in trading off internal and external R&D activities. Second, prior research has emphasized the moderating role of internal R&D investment in capturing unintentional external knowledge flows (Escribano et al., 2009) to achieve better innovative output, but has not taken into account how such firm's R&D capacity influences the knowledge flow through external R&D activities. By examining the moderating role of R&D capacity in this context, this paper provides new insights in the ability of firms to capture value by balancing internal and external R&D activities. More critically, it provides a contextual variable that allows us to better assess the complementarity vs substitution dichotomy.

To address these issues empirically, this paper investigates the internal and external R&D configuration of R&D-intensive Italian manufacturing firms. Based on two survey waves, I find that firms with an internal and external R&D system have greater innovative performance. Yet those firms that carry out more external than internal R&D activities perform worse. Moreover, I find that R&D capacity significantly moderates this curvilinear relationship. Firms with greater R&D capacity are able to benefit more from their external R&D activities in terms of innovative output. And they are able to do so by utilizing a smaller share of external R&D activities than those firms with a lower R&D capacity. These findings provide a deeper understanding of the relationship between internal and external R&D that goes beyond the classic opposition between complementarity and substitution. They imply that internal and external R&D activities are complementary up to a point after which they are substitute. More critically, the substitution effect is larger for firms with greater R&D capacity. Overall, these results provide a better understanding of the open innovation paradigm by suggesting that the opportunity cost for further opening up R&D borders is greater for firms with greater internal R&D capacity.

This paper is organized as follows. The next section examines the literature on R&D configuration, internal R&D capacity and innovation performance. It proposes a set of hypotheses that drives the analysis. The third section describes the database and the method. Finally, the results are elaborated and discussed.

2. Theoretical framework

2.1. From a closed to an open R&D system

To cope with an increasingly competitive environment, firms constantly invest in innovative activities and in creating technological capabilities. Nevertheless, focusing only on internal R&D and the development of internal capabilities and routines is no longer sufficient to cope with increasing costs, shorter product life cycles and greater technological complexities. These drivers have drastically mutated organizations, where the monolithic structure of an internally closed R&D is rapidly fading and shifting from a vertically integrated in-house R&D structure to an open R&D structure by tapping into external sources of knowledge through licensing, alliances and technology agreements (Hagedoorn, 1993). As illustrated by Whittington (1990), the ratio of internal vs external R&D expenditures more than doubled between 1967 and 1986, while R&D partnership has been growing tenfold in the last three decades (Hagedoorn, 2002).

The earlier models of innovation depicted it as an internally controlled process. The firm was the locus of innovation and the innovation process was kept away from competitors and other external players to secure that the knowledge was kept in-house.

When those innovations left the R&D labs, the successful ones were able to finance the subsequent in-house R&D activities. Since these activities were thought to be firm-specific, there was no need for cost sharing with other firms (Chandler and Hikino, 1990). However, this model of innovation was not always very efficient since, as noted earlier by Nelson (1959), it did not prevent spillovers. Firms funded R&D projects whose output was often appropriated and commercialized somewhere else.

Instead of closed innovation, one of the most recent models suggests an open innovation paradigm, where the R&D structure should be seen as an open system (Chesbrough, 2003; Chesbrough et al., 2006). This paradigm assumes that "firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology" (Chesbrough, 2003, p. 24). Firms are no longer the exclusive locus of innovation, but external and internal knowledge are equally important. An open R&D system allows firms to outsource R&D projects or technologies with no clear paths to market. By being exposed to external partners, these R&D projects may eventually find their way to market. It also allows firms to in-source external ideas, through the integration of suppliers, customers and external knowledge sources to increase firm innovativeness. However, according to Chesbrough and Teece (1996), openness implies an engagement with external sources, not a total reliance on them. Firms that depend entirely on external partners may lack internal R&D processes themselves and the ability to fully capture and assimilate external knowledge. This literature, however, does not explicitly evaluate the role of R&D capacity in balancing internal and external R&D activities for greater innovative output. The aim of this paper is to investigate this role.

The next section discusses theories and relevant empirical research on the relationship between R&D structure and innovative performance, the role of R&D capacity, and offers a set of hypotheses.

2.2. Internal and external R&D processes and innovative performance

Various theories of firm behavior explain the shift from closed to open innovation models and the increasing reliance on external R&D activities.

The transaction cost of economics (TCE) perspective suggests that the organization of economic activities is driven by the minimization of both production and transaction costs. From this perspective, the rise of R&D labs in the late 1940s could be attributed to lower costs of organizing and managing innovation in-house rather than through the market (Mowery and Rosenberg, 1989), given that R&D activities were considered firm-specific. As costs associated with R&D have been increasing (in TCE terminology, production costs), firms have minimized these costs by sharing them with other firms (Katz, 1986). Firms also realize that some R&D activities in non-core technology areas are not firm-specific and, therefore, they can either have joint R&D activities with other partners or outsource some of them because of the benefits in terms of cost saving and innovative output (Hagedoorn, 2002).

Rather than focusing on cost minimization, other theories emphasize how knowledge sharing and inter-firm linkages allow firms to achieve better performance (Dyer and Singh, 1998; Grant, 1996). Given the fast-changing technology environment, the knowledge base of the firm perspective suggests that firms could broaden their existing technology base and access new technology areas by exploring and integrating different specific knowledge areas through internal R&D activities and external technology outsourcing (Kogut and Zander, 1992). Since new developments in non-core technologies are increasingly fast, firms have limited capacity to screen and manage technological knowledge in-house.

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