Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs

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ARTICLE INFO
Available online 2 January 2013
Keywords:
Research manager
R&D expert
R&D training
Research collaboration
R&D outsourcing
SME
Firm size

ABSTRACT
The literature on 'open' innovation emphasises the need to engage in external knowledge relations in order to innovate. Particularly for SMEs, research cooperation and R&D outsourcing can offer possibilities to complement the often limited internal research resources. However, they also bring in their wake requirements in terms of absorptive capacity and managerial skills of the internal R&D personnel.

The paper focuses on the different requirements in terms of availability and training of research managers and R&D experts for research cooperation versus R&D outsourcing in SMEs. An empirical analysis of micro-level data provided by the OECD business R&D survey for Belgium reveals that the relation between R&D personnel requirements and research collaboration and R&D outsourcing depends upon the SME size. Therefore, to study this subject appropriately a distinction between very small, small, and medium-sized firms is relevant. Very small firms engage significantly less in research cooperation than medium-sized firms and the propensity to engage in research cooperation is positively associated with the share of PhD holders among the research managers and R&D experts. For R&D outsourcing a lower involvement is noted in medium-sized firms, and the propensity to outsource increases with the formal qualification level of the R&D personnel and with R&D training. Among the SME, small firms are most engaged in research cooperation and in R&D outsourcing. In the case of research cooperation they rely on highly qualified experts. For R&D outsourcing activities both the presence of research managers and R&D experts is important.

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1. Introduction
Research cooperation and R&D outsourcing are important ways to explore new research areas with relatively low capital and lower risk involvement in case of failure. However, decisions to engage in these activities make firm boundaries permeable in order to attract and use external knowledge and technology. They bring in their wake important implications for the organisation of innovation processes (van de Vrande et al., 2009) and should be seen in relation to the management, research expertise and qualification and training of internal R&D personnel. Based on initial work by Narula (2001) it can be expected that there are marked differences in terms of internal firm requirements for R&D management between activities related to research collaboration on the one hand and R&D outsourcing on the other hand. These differences can be situated both at the level of managerial resources and in terms of in-house capacity in order to utilise the results (Veugelers, 1997; Narula, 2001, Lucena, 2011). Aspects which are of particular importance for SMEs since these are faced with scale limitations and, in a context of open innovation, increasingly have to devote resources to other aspects of the value chain in order to effectively market the internally developed and externally sourced knowledge (van de Vrande et al., 2009).

Both research cooperation and R&D outsourcing in SMEs involve challenges to handle the increasing complexity and management of innovation and extend beyond the traditional R&D department (van de Vrande et al., 2009). This can be related to the crucial importance of human resources for R&D activities in firms (Allen and Katz, 1992). Innovation adoption in SMEs is particularly affected by the people around them and by the skills and knowledge of the internal personnel (Sawang and Unsworth, 2011). For the time being, in a context of open innovation and for SMEs, the management of innovation is rather going through a process of trial and error than that it is part of professional management (Gassmann et al., 2010).

The focus of this paper is on the identification of differences in the internal requirements of SMEs in terms of research managers.
and R&D experts as well as their qualification and training according to the firm's requirements in terms of research cooperation and R&D outsourcing in SMEs, the role of human resources for R&D, and size differences among SMEs are underdeveloped items in the literature on open innovation (Gassmann et al., 2010; Spithoven and Teirlinck, 2010).

The paper is structured as follows. Based on a literature review on research cooperation and R&D outsourcing in SMEs and the requirements in terms of research managers and R&D experts, Section 2 formulates the research question, Section 3 describes the dataset, and in Section 4 the empirical findings are presented. Section 5 highlights the main conclusions.

2. Literature review and research hypotheses

2.1. Research collaboration and R&D outsourcing

The growing complexity, huge budgets and risks related to innovation, the increased knowledge intensity, and the mounting competitive pressure for developing new products and processes, forces the R&D active company to look outside the firm's boundaries to complement its internal R&D efforts (Chesbrough, 2003; Coombs et al., 2003; Howells et al., 2003; Huang and Rice, 2009). External networking is an important way to do so and can take different forms of which research cooperation and R&D outsourcing are two prominent ones (von Hippel, 1988; Colombo and Garrone, 1996; Lazaric and Marengo, 2000; Chesbrough et al., 2006).

Research cooperation refers to both formal collaborative projects and informal networking activities with individuals and organisations (Chesbrough et al., 2006). It involves both knowledge generation contributing to the internal knowledge base (Cohen and Levinthal, 1990) and knowledge exchange of internally developed knowledge (Arora and Gambardella, 1994; Veugelers and Cassiman, 1999; Chiesa, 2001; Coombs et al., 2003). Firms may engage in cooperation in order to acquire missing knowledge, complementary resources of finance, to spread risks, to enlarge social networks, or to reduce costs (Hoffman and Schlosser, 2001; Mohr and Spekman, 1994). The firm's propensity to engage in research cooperation tends to increase with the internal R&D budget (Veugelers, 1997).

R&D outsourcing is also at the heart of the open innovation paradigm which emphasises that firms cannot (and should not) conduct all R&D activities internally and have to capitalise on external knowledge which can be licensed or bought (Gassmann, 2006; Veugelers, 1997) highlights that the technology strategy of a company needs to emphasise the link between in-house development and external acquisition. In the absence of an in-house R&D group, outsourcing allows firms to utilise externally held knowledge by means of recognising and understanding potentially valuable new knowledge, assimilation of valuable new knowledge to transformative learning, and application of the acquired knowledge to create new knowledge and commercial outputs through exploitative learning (Cohen and Levinthal, 1990). If the external knowledge is actively used as a problem-solving capability it supports a skill (compared to experience) if it is tacit, and it becomes know-how (compared to information) if it is coded (Kogut and Zander, 1992). As such, a higher level of internal knowledge is helpful for firms to understand and acquire external knowledge. This external knowledge acquisition can help firms to accumulate relevant experiences and routines for knowledge sharing and interpretation, which in turn can promote the firm's absorptive capabilities (Eisenhardt and Martin, 2000). Veugelers (1997) used R&D departments with personnel holding a doctorate degree (as a measure for absorptive capacity) and found that their presence positively influences the effect of contracting on internal R&D. She also stresses that the complementarity between in-house R&D and external know-how depends on an optimal tuning to absorb effectively external know-how of in-house R&D groups. High qualified employees can be associated with higher R&D investment levels (Roach and Sauermann, 2010) and education and training are found crucial to innovation (Lam, 2005). High educational levels can be supposed facilitating the detection and management of relevant external knowledge flows (OECD, 2008), which are key ingredients in absorptive capacity (Roach and Sauermann, 2010). In particular in the case of doctorate degrees the body of research supporting this view is considerable (Stuart and Ding, 2006; Bercowitz and Feldman, 2008; Baba et al., 2010).

Second, training (and especially on-the-job-training) is considered an effective mechanism for transferring less-complex and
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