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The relation between R&D spending and patents: The moderating effect of collaboration networks



María Teresa Bolívar-Ramos

Professor Serra Húnter, Autonomous University of Barcelona, School of Economics and Business. Campus de Bellaterra, Edifici B, Business Department. Bellaterra, Barcelona, 08193, Spain.

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ABSTRACT

Firms collaborate with partners around the world to facilitate knowledge exchanges that, combined with their internal R&D, may enhance patenting activities. However, the location and types of these networks condition the benefits companies gain from their collaborations. Hence, how do different geographical collaboration networks affect the relation between R&D spending and patents? This empirical study, based on a sample of 3101 Spanish firms, suggests that firms that invest in R&D and join national or regional collaboration networks show a stronger patenting propensity than companies that do not join these networks. However, engaging in more international collaborations has no significant effect.

1. Introduction

The relationship between R&D spending and patenting has inspired considerable research interest over the past two decades (Griliches, 1990; Hall and Ziedonis, 2001; Penner-Hahn and Shaver, 2005; Somaya et al., 2007). This interest stems from the role R&D and patents play in sustaining the foundation of knowledge-based competition, influencing the scope and the opportunities available to the firm, and improving the potential to achieve growth and profitability (Kaul, 2012). Research also underscores the vital importance of companies' R&D in increasing their stock of knowledge and the generation of inventions (Hagedoorn and Wang, 2012), and the use of patents, a key means of protecting intellectual property rights, to appropriate the returns of R&D and prevent imitation of firm inventions, among other reasons (Blind et al., 2006).

Even though past research has shown that R&D spending positively affects patenting activity (Hall and Ziedonis, 2001; Nicholls-Nixon and Woo, 2003; Penner-Hahn and Shaver, 2005), it also indicates that investing in R&D is not the only factor that conditions the decision to patent (Pérez-Luño and Valle-Cabrera, 2011; Somaya, 2012). Companies seem to benefit also from joining collaboration networks – i.e. linkages with different partners to acquire and share knowledge and resources (Baum et al., 2000)–, by stimulating R&D activities and harvesting these activities in gaining patents (Sampson, 2007). Given the dispersion of innovative activities around the globe, the geography of such networks suggests that these collaborations are not equally distributed in space, what in turn can affect the potential outcomes of the inventive process (Acs et al., 2002). Traditionally, the literature has distinguished between national and international collaboration networks (Liu et al., 2013; Wagner and Leydesdorff, 2005). National collaboration networks are typically embedded in a single country whereas international ones extend well beyond national frontiers (Leung, 2013). Besides these two categories, however, multiple studies also highlight the need to contemplate an intermediate level, labeled as regional that, although international in nature, encompasses a set of countries closely located that share a strong historical background, such as the European Union (Cappelli and Montobbio, 2016; Ó hUallacháin and Kane, 2015). Thus, to provide an accurate conceptualization, separating national, regional and international collaboration networks is key, as spatial factors, historical

E-mail address: mariateresa.bolivar@uab.cat.

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roots, and institutional forces that characterize each type of network are critical elements to consider when studying inventive activities that bring together partners from the same or different geographical contexts (Glänzel and Schubert, 2004; Liu et al., 2013).

In light of above arguments, the objective of this study is to explore the conditions under which joining collaboration networks, at different geographical levels, may be beneficial to boost the firm's ability to convert its R&D investments into patents. Certainly, the access and recombination of both internal and external knowledge shapes the firm's ability to generate novel ideas and innovate (Iwasa and Odagiri, 2004; Tzabbar et al., 2008). Yet, networks embedded in different contexts provide recipient firms with different streams of knowledge that have unique and particular characteristics (Liu et al., 2013; Vasudeva et al., 2013). Moreover, spatial distance can interfere in the way firms derive advantage from their partners' resources, as communication costs and barriers to knowledge flows may hinder knowledge transfer and integration (Cappelli and Montobbio, 2016). For this reason, recent research calls attention on the importance to understand how the geography of networks affects inventive and innovative activities (Liu et al., 2013). In this sense, it should be further explored how related resources improve patenting performance when combined with R&D activities, with a special focus on the contextual factors that moderate the R&D spending and patenting relationship (Somaya et al., 2007). Thus, to address this research gap, the study explores the following question: how do different types of collaboration networks (national, regional, international) affect the relation between R&D spending and patents?

The findings of the research, based on a sample of 3101 Spanish technology firms, suggest that the positive effect of R&D spending on patenting propensity is higher when companies engage in national or regional collaboration networks. More specifically, when the company participates in just one collaboration network, regional networks offer the greatest benefits, as they involve the best balance between moderate geographical closeness that facilitates knowledge transfer and knowledge diversity. Additional tests also reveal that when firms participate in all types of collaborations – i.e. national, regional and international-, the problems associated with managing such diverse collaboration networks become more serious (e.g. coordination, complexity in integrating knowledge inputs, etc.). In this scenario, only national collaborations, closer and more similar to focal firms, are useful mechanisms to strengthen the R&D spending and patenting relationship.

This paper contributes to the literature in several ways. First, it extends the technology strategy literature (Cuervo-Cazurra and Anrique-Un, 2010; Zahra and Bogner, 2000) by explaining how firm's strategic decisions to invest in R&D and engage in collaboration networks predict firm-patenting performance. Second, the study clarifies the potential benefits that can be derived for innovative activities from national, regional and international collaboration networks. A three-level classification, that goes beyond the traditional distinction between national and international (Liu et al., 2013), contributes to understanding in more detail how geographical and contextual factors condition the effectiveness with which different knowledge inputs and other resources are transferred, combined and then harvested by means of patents (Somaya et al., 2007). Thus, the current study highlights that only national and regional collaboration networks may be advantageous to that end. Finally, the study extends the Knowledge-Based View (KBV) of the firm (Grant, 1996; Nonaka and Takeuchi, 1995), by discussing which combinations of internal and external knowledge sources may increase the firm's ability to develop novel ideas and patents that can generate value and competitive advantage.

This remainder of the paper is structured as follows. The next section presents the study's theory and hypotheses. Then, the methodology and the empirical analysis to test these hypotheses are explained, and the results obtained are discussed. Finally, the implications and limitations of this study, as well as recommendations for future research, are presented.

2. Theory and hypotheses

2.1. The relation between R&D spending and patents

R&D spending and patents constitute two critical strategic resources for a firm's success (Penner-Hahn and Shaver, 2005). In current dynamic business environments, R&D spending is key to develop new knowledge, improving a firm's ability to invent and innovate (Alexy et al., 2013). Patenting is considered the strongest legal form of protection of R&D outcomes, helps firms to keep their competitive advantage derived from invention (Ceccagnoli, 2009), limits others' ability to copy and carry out duplicative inventions (Shane, 2001), and ensures the appropriability of the returns derived from R&D investments (González-Álvarez and Nieto-Antolín, 2007; Knott and Posen, 2009).

Previous research indicates that R&D spending positively affects patenting performance (Mudambi and Swift, 2013; Nicholls-Nixon and Woo, 2003). By investing in R&D, firms produce new knowledge that nurtures novel discoveries, and increase their chances of developing patentable inventions through the creation of fertile settings for finding solutions to current problems and challenges (Somaya et al., 2007). Further, internal R&D improves the firm's ability to efficiently screen, acquire and exploit external knowledge, what enhances the potential for patenting, as it provides an opportunity to link and associate new technological ideas (Nicholls-Nixon and Woo, 2003). Overall, promoting the creation of knowledge inputs, that can be later recombined, is not only positively associated with increased creativity and invention, but also with the creation of value by means of patents (Kaplan and Vakili, 2015).

Contrary to widely held assumptions, some authors have failed to show a clear link between R&D spending and patenting (Bessen and Hunt, 2007; Arora et al., 2008). Other researchers have even suggested that patenting propensity can decrease with an increase in R&D expenditures (Hagedoorn and Duysters, 2002). This may be explained because patents can be costly, disclose information about innovations, and present a limited life in dynamic industries (Zahra and Bogner, 2000). Moreover, although internal R&D facilitates knowledge stocks creation, its exploitation and performance implications in terms of patents and innovation vary depending on the interdependencies and configuration of resources (Tzabbar et al., 2008), as it will be discussed in the next section. Another factor to take into account is that different trends seem to apply in different geographical contexts. For instance, in countries like Spain, firms

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