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Co-patent, financing constraints, and innovation in SMEs: An empirical analysis using market value panel data of listed firms

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ABSTRACT

We have studied how small and medium-sized firms (SME) can overcome the liability of smallness (Clegg et al., 1996; Thorgren et al., 2012) and obtain value from co-patents. We examined the relationship between the co-ownership of the patent and the firm's market value, along with the moderating role of government subsidies and upstream supplier's trade credit. The study finds that co-patent intensity is negatively correlated with the SME's market value. Further, supplier financing mitigates the negative relationship between the co-patent intensity and the market value of SMEs while the government subsidies strengthen the negative relationship between the co-patent intensity and the market value of SMEs. The results above imply that because the patent needs to be shared among the partners, this raises capital market's perception of the SME's commercial uncertainty and has a negative impact on the market value of SMEs. However, like general patent in which it signals the strength of SMEs in R&D, co-patent also reduces the external market's perception of an SME's technological uncertainty. The SME thus attracts more external funding. These findings provide us a more comprehensive understanding of the motivation of SMEs in co-patenting and how SMEs overcome the liability of smallness in capturing value from the co-patent.

1. Introduction

Collaborative R&D has been one of the hottest topics in open innovation management, and also one of the most important issues for science and technology policy makers (Chesbrough et al., 2006; Geum et al., 2013). Existing research emphasizes the need for cooperation in R&D activities. With the increasing complexity of R&D activities, few firms can complete all the R&D work on their own (Flipse et al., 2013; Un, 2017). In the open innovation environment, even the most capable organizations must take the identification, acquisition and utilization of external knowledge as the core process of innovation (Caner et al., 2014). More and more firms are devoting human and financial resources to collaborative R&D activities, and they look forward to acquiring greater market value through cooperation (Berends et al., 2007; Wang et al., 2015).

In order to enhance the mutual trust of the partners and promote the exchange of knowledge in the process of cooperation, the technological achievements produced by collaborative R&D are often presented in the form of co-patents (Goetze, 2010). The so-called co-patent refers to a patented invention that is jointly owned by two or more units (Belderbos et al., 2014). With the development of collaborative R&D and the improvement of the intellectual property system, the number of co-patenting has continued to grow rapidly (Belderbos et al., 2014). In the face of this practice, the empirical research on co-patent is rather scarce. In the only

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studies, scholars have explored the relationship between co-patent and the firm's performance. Unfortunately, these studies have not yet come to a consistent conclusion on the relationship between co-patents and the market value of the firm. In some studies, the study found that co-patents are positively correlated with the market value of a firm (Briggs, 2015). For this kind of finding, existing research mainly explains from the perspective of knowledge complementarity. In this view, compared with independent R&D, co-operation can help firms, especially SMEs with the liability of smallness (Clegg et al., 1996; Thorgren et al., 2012), bring more information and resources needed for R&D. In the process of working with external organizations, SMEs can be more exposed to new information about technology, emerging markets and consumer demand for development. In this way, the collaborators are equivalent to the extended tentacles of SMEs, in which they are more likely to integrate the necessary information and identify the opportunities with high market potential (Fleming et al., 2007). Research shows that alliance partners with complementary knowledge have positive impacts on the development of radical innovations (Cohen and Caner, 2016). Therefore, from the perspective of internal and external knowledge complementarity, the co-ownership of patents means that firms have more opportunities to combine complementary knowledge resources with each other. The accelerated flows of knowledge inside and outside will promote the creation of more new technologies and generate greater value (Bruno Cassiman and Reinhilde Veugelers, 2006). In other studies, however, scholars have found evidence of negative correlations between co-patents and the market value of a firm (Hagedoorn and Cloodt, 2003). Other studies have found mixed results that are positive and negative (Belderbos et al., 2014). For such findings, the existing mainstream view is from the perspective of the interplay of collaborators in the industry. The idea is that a co-patent encourages more opportunistic behaviors and reduces the ability of firms to monopolize patents (Belderbos et al., 2010). Specifically, in the case of co-patenting, both applicants have the right to dispose of the invention. This means that a co-patent creates a duopoly, in which the co-owners are at risk of competing with each other (Hagedoorn and Cloodt, 2003). There are a few examples illustrating this risk of value appropriation: if Firm A and Firm B are the co-owners of the patent, Firm B has the right to license the patent to Firm C (Firm A's potential competitors) without the consent of the Firm A (Carlson and Barney, 1998). Therefore, from the perspective of partner opportunism, studies suggest that the co-ownership of patents increases the partners the possibility of malicious use and leakage of a firm's core technology, which makes the firm facing huge risks. In particular, the patent co-ownership creates more challenges for firms to capture value from co-patents when the convergence of application domains between co-patent holders are very high.

In general, these two views have their rationality. The view of the interplay of internal and external knowledge explains the original intention of co-patent. And the view of partner opportunism explains well the potential negative impact of co-patent on the market value of firms, also explains why it is difficult for two firms in the fields that have high overlapping to collaborate successfully. However, the inconsistency of the empirical results indicates that there is still a great room for the improvement in the theoretical analysis of the relationship between the co-patent and the market value of the firm. We argue that the focus of both views mentioned above is mainly on the technological level, such as examining how to improve the firm's technological ability or examining how to prevent the malicious use of a co-patent to leak the firm's core technology. In these studies, the role of firm size in creating and capturing the value of co-patent is not clear. Existing co-patent research does not consider the specific impact of the firm size on the market performance of the firm with co-patents. Research shows that the firm size is a very important heterogeneous characteristic of firms, which has important impact on many outcome variables including firm's innovation performance and environmental performance (Dong et al., 2014; Subrahmanya, 2015). However, thus far, there has been no literature on the co-patent practice of SMEs. Research shows that SMEs are important players in open innovations and need to study the collaborative R&D practices of SMEs (Bocken et al., 2014; Gu et al., 2016; Spithoven et al., 2013).

In particular, the liability of smallness is a distinguishing feature of SMEs. Studies show that because of the liability of smallness, many SMEs are faced with larger constraints in funding and R&D, and it is difficult for them to obtain economies of scale and thereafter maximize the value of new technology (Battistella et al., 2015). Can be inferred that, therefore, under the co-ownership of the patent, it is difficult for an SME to follow the open innovation pattern found in the literature. SMEs have no large-scale R&D team working together to integrate new knowledge in the patent rapidly with existing knowledge, coping with the complex problems in new product development, and finally improving the generalizability of the firm's technology (Ardito et al., 2016). By contrast, can be expected, when the two co-owners of the patent are in the same industry, the larger one will be more likely to leverage economies of scale to achieve monopoly. The smaller one would take a slower step and are in an undesirable position. Large firms can exclusively reap the value of co-patent by virtue of economies of scale without malicious appropriation. Further, the liability of smallness will also be seen in the case of collaborations with universities that are thought to have no direct competition with firms in the previous studies (Franco and Haase, 2015). SMEs tend to be relatively weak in technological capabilities because of their liability of smallness. In the cooperation and development process with universities, the university dominates the research progress. In this process, it is difficult for SMEs to require the university to accelerate research to advance the progress of the commercialization. Furthermore, studies have shown that not all universities that work with firms have a well-developed technology transfer office (TTO) (Villasalero, 2014). Considering the research interest of many universities focuses on socially-desirable research, in the absence of a well-established TTO mechanism, it is difficult for SMEs to commercialize the co-patented technology rapidly. This is also one of the important reasons why many universities – industry collaborations generate fewer patent applications than those in inter-firm collaborations (Kay et al., 2014).

Based on the above considerations, we believe that it is necessary to investigate the impact of firm size on the value capture of firms in co-patent. In particular, we are not quite clear about how SMEs with the liability of smallness capture value from co-patents. In-depth analysis on this problem, will not only deepens our understanding of the motives of SMEs to share the patent ownership with others, but also makes contributions to promote open innovation in SME.

The study of information asymmetry theory indicates that signaling is an important motivation for firms to participate in a certain

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