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How do firms develop capabilities for scientific disclosure?

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ABSTRACT

Many profit-oriented companies publish research outcomes in scientific literature. However, very few studies have focused on the capabilities that enable firms to engage in scientific disclosure with consequent potential benefits for the firm. We propose that specific investments are required in order to engage in scientific disclosure activities, since the disclosure process requires distinctive capabilities. This paper empirically analyses the relationship between the composition of industrial research labs' personnel, basic research and scientific disclosure capabilities. Our econometric analysis provides evidence that scientific disclosure requires specific human resource allocations, which supports the view that scientific disclosure is not just a by-product of standard R&D activities.

1. Introduction

From a traditional viewpoint, there is a strong incentive for firms to keep research outcomes secret because of the public good characteristics of knowledge which may result in unintended spillovers (Arrow, 1962). Consequently, it appears paradoxical that firms investing in basic research (Rosenberg, 1990; Pavitt, 1991) do not minimise knowledge outflows but instead publish extensively in scientific journals (Hicks, 1995; Stephan, 1996). In order to explain this seemingly counterintuitive behavior of firms, recent literature challenges the traditional view and emphasises several potential benefits of voluntary dissemination of knowledge outcomes in scientific journals.

The disclosure of knowledge is regarded as beneficial if one wants to access external knowledge based on non-monetary reciprocal exchange mechanisms. Furthermore it reduces research and transaction costs. Academic scientists are, potentially, more willing to interact with company scientists who make their own contributions to Open Science (Hicks, 1995; Simeth and Raffo, 2013). Disclosure may also actively stimulate follow-on research if interesting intermediate outcomes are put into the public domain (Alexy et al., 2013). Moreover, given the desire of many researchers in industry to publish in academic journals, companies can leverage the permission to publish as an active human resource instrument (Hicks, 1995; Stern, 2004; Sauermann and Roach, 2014). Scientific disclosure is also potentially helpful in promoting science-based products, for instance in the pharmaceutical or medical instruments sector, based on the certification role of the peer-review process (Azoulay, 2002; Polidoro and Theeke, 2012). Further benefits include signalling one's R&D capabilities to other firms and to public funding authorities, as well as the use of disclosure to retain the freedom to operate in competitive environments by establishing prior-art (Lhuillery, 2006; Penin, 2007; Della Malva and Hussinger, 2012).

Although firms may gain competitive advantages by making scientific disclosures, it remains unclear *how* such disclosure strategies can be achieved. We propose that pursuing scientific disclosure strategies is challenging for firms and requires specific investments that go beyond those needed for the creation of knowledge outcomes. Specifically, we argue that the knowledge codification process and the social rules of the academic community are difficult to master. Accordingly, disclosure is not simply a by-product of firms' usual R&D activities. The development and provision of, what we call hereafter "disclosure capabilities", may potentially create costs and tensions with other activities (see Cockburn et al., 1999;

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Gittelman and Kogut, 2003; Kinney et al., 2004; Liu and Stuart, 2014).

The sparse existing literature on the origins of firm strategies related to Open Science focuses primarily on resources for basic research. Although the importance of basic research in achieving outcomes eligible for scientific publication is often taken for granted, the relationship between basic research and scientific disclosure is ambiguous from a conceptual viewpoint, as applied research might also lead to publishable outcomes (Rosenberg, 1990; Stokes, 1997; Murray, 2002). In this respect, empirical evidence is mixed (Adams and Clemmons, 2008; Sauermann and Stephan, 2013). Moreover, in order to develop capabilities for scientific publication, a dedicated human resource policy may be seen as crucial, given the importance of researchers in scientific inquiry (Stern, 2004; Sauermann and Stephan, 2013). While not directly addressing scientific disclosure, certain related studies emphasize the role of individuals in the creation of technological outcomes: the role of scientists' personal motivation (Stern, 2004; Sauermann and Cohen, 2010), academic training (Gruber et al., 2012), the prevalence of star scientists (Zucker et al., 2002) and team composition (Lazear, 1999; Bercovitz and Feldman, 2011; Faems and Subramanian, 2013) have all been considered as relevant human-resource related determinants.

In this paper, we provide insights concerning the allocation of resources in the R&D department of firms, with particular focus on two potentially crucial enablers for scientific disclosure strategies – basic research orientation and R&D team composition. Our main interest therefore does not lie in analysing how knowledge outcomes can be produced but how disclosure of R&D results in scientific journals can be realized. In addition, we compare specific resource allocations in terms of their impact on patent-based appropriation strategies, which can be viewed as a natural benchmark indicator for scientific disclosure. Moreover, when surveying scientific output, publications can be differentiated according to co-authorship and quality. Therefore, we do not only rely on comprehensive R&D information on the input side, but consider the potential heterogeneity in disclosed industrial scientific outputs.

Our econometric analysis uses comprehensive information from the 2007 extended French R&D survey matched with scientific publication and patent data for a sample of 2517 firms performing R&D. The results support the view that specific capabilities which go beyond the creation of knowledge outcomes are required to pursue strategies of scientific disclosure, and are in part not crucial for patent-based appropriation strategies. Firms engaging in scientific disclosure have higher shares of researchers with the following characteristics: hold a doctoral degree, are young, have experienced international training, and are part of more diverse teams. Interestingly, the (basic) research orientation is only a partially relevant input dimension.

The paper is comprised as follows: in Section 2, we present the framework and hypotheses. Section 3 describes the data and sample composition, as well as the econometric model. In Section 4, we present and discuss the results. Section 5 concludes.

2. Shaping disclosure capability

Firms invest in R&D to achieve competitive advantage in dynamic scientific and technological environments. We argue that R&D decisions do not only determine knowledge production and absorption capacity but also the capabilities for knowledge disclosure. Disclosing knowledge in scientific journals is not necessarily a trivial task once knowledge outcomes have been created: it may require specific competences with regard to efficient knowledge codification and the selection of which outcomes to publish or to keep secret ("selective revealing", see Alexy et al., 2013; Gans et al., 2011). Scientific publishing can be regarded as a complex process since researchers are required to have in-depth knowledge of the academic research field in question in order to be able to determine which areas of academic literature their research belongs in. Researchers need to have the ability to systematically construct theoretical arguments and to integrate theory and empirical findings into coherent documents, while complying with the peer-based norms of the given research field (Merton, 1973; Bazerman, 2000; Delamont and Atkinson, 2001; Fayard and Metiu, 2014). Accordingly, publication is likely to be much more than a simple by-product of research which does not require costly investments. The optimal investment level in disclosure capabilities is difficult to determine ex-ante: firms invest in disclosure capabilities today to be able to choose to use them or not in the future, depending on whether the initially uncertain R&D project generates interesting outcomes (McGrath and Nerkar, 2004; Cohen and Levinthal, 1994; George, 2005). Investments in scientific disclosure capabilities compete for the same resources as other costly R&D capabilities, such as patenting or absorption. Even though some economies of scope can be expected for the different investments in knowledge codification tasks, a firm's disclosure capabilities can be considered distinctive from its capabilities to pursue patent-based appropriation strategies, as the codification of the knowledge is performed differently. Filing patents requires the precise drafting of language concerning desired protection as well as the documenting of the technical applicability of an invention. In contrast, a scientific publication addresses fundamental cause–effect relationships that have the potential to shape theory (George, 2005; Meyer and Bhattacharya, 2004; Fayard and Metiu, 2014). Based on the importance of individual researchers in scientific enquiry, we develop five hypotheses that investigate four researcher-related dimensions and the basic research constituents of disclosure capabilities. Although the primary focus is on analysing scientific disclosure, we also consider appropriation via patents as a benchmark for scientific disclosure in the empirical analysis.

2.1. Research orientation

In order to disclose research results in scientific journals, firms need to produce research that is of interest to the scientific community. In general, the incentive for companies to focus on applied research is greater than that for basic research since the outcomes can be more easily appropriated (Aghion et al., 2008; Nelson, 1959). Nevertheless, firms frequently engage in basic research, since it allows them to gain first-mover advantages, absorb external knowledge, and connect to scientific networks (Cohen and Levinthal, 1989; Rosenberg, 1990; Cockburn and Henderson, 1998; Zucker et al., 2002). Performing basic research may also allow firms to understand the scientific landscape better and to determine the potential of research findings fit for academic publication. Therefore the balance between research and downstream development can influence the opportunities for scientific publication. However, applied research may also lead to scientific publication since it also potentially generates generic insights (Stokes, 1997; Murray, 2002; Lim, 2004). From an empirical point of view, this link between fundamental research in industry and its academic publication has not been explored in any great depth. Based on a sample of the top 200 U.S. R&D firms, Adams and Clemmons (2008) showed that a firm's past internal basic research is positively related to its current scientific production, suggesting that industrial science is a cumulative activity and that basic research is a strong predictor of publication activity. On the other hand, empirical evidence at the individual scientist level has shown that the relationship between basic research orientation and the individual scientist's patent and publication output is somewhat weak. In their study of industrial researchers, Sauermann and Stephan (2013) found a premium on