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Contracting over the disclosure of scientific knowledge: Intellectual property and academic publication☆

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ABSTRACT

This paper provides a theoretical investigation of the tension over knowledge disclosure between firms and their scientific employees. While empirical research suggests that scientists exhibit a "taste for science," such open disclosures can limit a firm's competitive advantage or ability to profitably commercialize their innovations. To explore how this tension is resolved we focus on the strategic interaction between researchers and firms bargaining over whether (and how) knowledge will be disclosed. We evaluate four disclosure strategies: secrecy, patenting, open science (scientific publication) and patent-paper pairs providing insights into the determinants of the *disclosure strategy* of a firm. We find that patents and publications can be complementary instruments facilitating the disclosure of knowledge-providing predictions as to when stronger IP protection regimes might drive openness by firms.

1. Introduction

An enduring puzzle in the management of innovation is that many firms fund basic research and embrace practices from open science (such as publishing and conference participation) alongside their more traditional and applied development activities. Industry scientists even appear to have internal career paths tied to publishing success and career ladders that resemble those in academia with advancement solely through individual technical contributions (O'Mahony and Dahlander, 2011). To explain these observations, scholars have hypothesized that open science practices serve as a "ticket of admission" to absorb scientific knowledge from academia, allowing firms to more rapidly reach the frontier and exploit first mover advantages (Rosenberg, 1990; Cohen and Levinthal, 1990). By implication, firms adopting open science practices are more productive. However, upon empirical examination, *the adoption of open science by firms is found to be negatively correlated with the incomes of scientists at those firms* (Stern, 2004). Moreover, patent quality may be negatively correlated with the magnitude of scientific impact of associated papers (Gittelman and Kogut, 2003). This suggests that scientists themselves have a "taste for science" (Merton, 1973; Dasgupta and David, 1994) and that, in fact, firms face costs in engaging in scientific practices. This raises a critical question for scholars and for managers of innovation: What types of disclosure practices – particularly with regards to open and closed practices – should firms adopt? And, relatedly, as firms make these disclosure choices, what tradeoffs are being made with regards to firm-level competitiveness on one the hand and employee preferences one the other?

The importance of exploring the collection of disclosure practices that firms should adopt reframes the question of open science in a broader context. Specifically, while much of the current literature counterpoints open science with "closed" practices, such as intellectual property, there exist a wide variety of disclosure strategies that might be pursued. For example, trade secrets are

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widely used in industry but are rarely adopted in academia. Moreover, one of the distinguishing features of science as practiced by industry (compared to that practiced in academic settings) is the greater adoption of mechanisms to protect intellectual property. This includes patent protection, which, of course, involves some disclosures but can restrict use, as well as trade secrecy. Indeed, there is an increased incidence of patents being associated with publications of the same underlying research (Murray, 2002; Azoulay et al., 2009) and this incidence is greater for industry than academia (Murray and Stern, 2007).

The second of our key questions relates to the contractual relationship regarding disclosure between scientists and the firms who employ them. Studies of scientists' preferences for open science ignore the fact that firms have preferences and these preferences may be at odds with those scientists who desire open publication. Moreover, these studies ignore the fact that scientists may have more complex preferences over the bundle of disclosure approaches – not simply publication. For example, the recent Twitter employment contract suggests that scientists may have preferences over the use of their intellectual property: the firm provided employees with significant future control rights over the use of their patents, including commitments not to use the patents in "troll" situations.[1] A similar commitment to "open science-like" practices can be observed with IBMs agreement to contribute intellectual property related to open source software. To complicate matters, scientists may have preferences with regards to combinations of disclosure practices. The backlash over the patenting (and publishing) of the Oncomouse discovery in the 1980s demonstrates that (academic) scientists resist attempts to exclude the use of research results through intellectual property protection and generally look with skepticism on practices that allow unfettered commercial exploitation of research (Bok, 2003). Does this imply that industry scientists will be less interested in open science publication practices when they are combined with simultaneous patenting? Put more broadly, what is the negotiation that arises between industry scientists and the firms who employ them with regards to disclosure?

This tension – that patent protection may harm open science – also resides within the formal economics literature; although often not explicitly. A well-known fact about the creation of scientific knowledge – encapsulated in Newton's famous "standing on the shoulders of giants" declaration – is that it relies on past knowledge. Specifically, for past knowledge to enhance the productivity of current research requires both that it is produced and that it is disclosed so it can be accessed by future researchers; a feature of knowledge production that is not axiomatic (Mokyr, 2004).[2] Instead, knowledge disclosure relies upon a complex and interacting set of institutions to provide incentives for one generation of knowledge producers to reveal their ideas and enable spillovers for the next (Dasgupta and David, 1994; Furman and Stern, 2011). From an economic perspective, when commercial motives are critical for the funding of research, there is little incentive to permit such disclosures as these may, by enabling competitors, place current returns at risk and, by shortening the economic life of their products, future returns at risk. Under such conditions, the degree to which knowledge disclosures actually take place becomes a central, but, to date, understudied question. This paper's contribution is to provide a microeconomic understanding of what disclosures, if any, arise in ways that enable the spillovers that lie at the heart of knowledge accumulation.

1.1. Summary of results

We consider disclosure strategy from the perspective of a single research project that generates a dual outcome – a product of immediate commercial value and scientific knowledge that provides the foundation for both future research in subsequent generations and for potential competitors in this generation. That is, we examine research projects taking place in what has been termed Pasteur's Quadrant (Stokes, 1997) after Pasteur's simultaneous advances in vaccination (a "product" of immediate commercial value) and microbiology (scientific knowledge of high value for future generations of innovators). Our key insight, however, is just because an idea can be of value to both science and commerce does not automatically mean it will be utilized as such.[3]

For projects generating "dual knowledge" of this type, the set of possible disclosure choices is comprised of two broad elements: First, given the production of immediately useful knowledge, it is possible to pursue a *patent*, filing a patent application disclosing what precisely is protected. If a decision is made *not* to patent, then this can lead to knowledge being kept secret. Second, given the production of scientific knowledge of potential interest to future generations, the results from the research project may be *published*. This represents the collection of activities that comprise academic dissemination including publication as well as the presentation of papers that augment the stock of publicly available knowledge (Dasgupta and David, 1994). Taken together, this leads to four disclosure regimes – patenting, publishing, secrecy and patent-paper pairs (when both patents and publications are used as a disclosure strategy). This last disclosure strategy, while not widely discussed in the literature, is widespread particularly in science-based industries (Murray, 2002; Gittelman and Kogut, 2003; Lim, 2004) as well as among academic scientists (Azoulay et al., 2009; Fabrizio and Di Minin, 2008). In fact this is the type of disclosure assumed to arise in the endogenous growth literature although not explicitly discussed as such.[4]

The choice of disclosure regime is the outcome of negotiations or similar voluntary decision-making between academically-oriented scientists and their commercially-oriented funders. A tension exists because a scientist providing labor for the project cares about disclosure via academic publications as of the basis for the rewards or kudos they receive from contributing to the stock of scientifically valuable knowledge (Merton, 1957). On the other hand, firms, the providers of capital for the project, often have no similar interest and, in fact, operate in environment where disclosures can harm their commercial returns. In examining this tension, we build on the important work of Aghion et al. (2009) who study how the incentive conflict between researchers and their funders over research *direction* impacts the organization of the research enterprise. In contrast, we model the disclosure strategy that arises when scientists have clear preferences for the publication of sci-

[1] https://blog.twitter.com/2012/introducing-innovators-patent-agreement (accessed 12.09.14).

[2] Interestingly, modern theories of endogenous growth treat these as axiomatic – assuming that past knowledge is a key input driving future research efforts (Romer, 1990). Romer is explicit that each new idea results in both a patent (leading to a product) and an addition to the knowledge stock that he assumes is automatically disclosed. Indeed, this linkage is critical to understanding persistent increases in per capita income (Jones, 1995) and hence, its treatment as axiomatic highlights a potential missing microfoundation for those models.

[3] The model here abstracts from the impact of what we call the disclosure environment (that impacts on the chosen disclosure strategy) has on the type of research scientists pursued. However, including this would not change the results in terms of how the environment impacts on the strategy. Nonetheless, it may be a fruitful direction for empirical research to identify the choices scientists make.

[4] For example, Romer writes: "The crucial feature of the specification used here is that knowledge enters into production in two distinct ways. A new design enables the production of a new good that can be used to produce output. A new design also increases the total stock of knowledge and thereby increases the productivity of human capital in the research sector." (Romer, 1990, S84).

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