



The rise and fall of interdisciplinary research: The case of open source innovation

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ABSTRACT

A large, and purportedly increasing, number of research fields in modern science require scholars from more than one discipline to understand their puzzling phenomena. In response, many scholars argue that scientific work needs to become more interdisciplinary, and is indeed becoming so. This paper contributes to our understanding of the evolution of interdisciplinary research in new fields. We explore interdisciplinary co-authorship, co-citation and publication patterns in the recently emergent research field of open source innovation during the first ten years of its existence. Utilizing a database containing 306 core publications and over 10,000 associated reference documents, we find that inquiry shifts from interdisciplinary to multidisciplinary research, and from joint puzzle solving to parallel problem solving, within a very few years after the inception of the field. “High-involvement” forms of interdisciplinary exchange decline faster than “low-involvement” forms. The patterns we find in open source research, we argue, may be quite general. We propose that they are driven by changes in task uncertainty and the ability to modularize research, among other factors. Our findings have important implications for individual scholars, research organizations, and research policy.

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1. Introduction and overview

Many fields in modern science require scholars from more than one discipline to effectively address principal research questions (Becher and Trowler, 2001; Hessels and van Lente, 2008). Interdisciplinary fields are also more likely to provide findings of high novelty (Dogan and Pahre, 1990; Bartunek, 2007). Many scholars have argued that scientific work needs to become more interdisciplinary, and is indeed becoming so (Chubin, 1976; Nissani, 1997; Metzger and Zare, 1999; Forman and Markus, 2005).

At the same time, interactions across disciplines can be more costly than within-discipline interactions (Klein and Porter, 1990). Whether or not the benefits outweigh the costs of interdisciplinary research is contingent on the nature of the scientific problem at hand as well as the availability and distribution of prior related knowledge (Birnbaum, 1981; Kötter and Balsiger, 1999). Changes in these factors can therefore be assumed to affect the effectiveness and efficiency of interdisciplinary research.

However, there are very few studies to date that measure how interdisciplinary collaboration among researchers evolves over

time and theorize the contingencies. We believe that this is an important gap to address. It has wide-ranging implications for individual researchers, research organizations and research policies that seek to adopt or promote the most efficacious research strategies. Scholars as well as research practitioners and managers will wish to know when interdisciplinary work is most appropriate.

This paper contributes to filling this gap by investigating three principal questions:

- (I) Do scholars from different disciplinary backgrounds jointly solve the puzzles of the new research field, or do they mostly co-evolve their understandings without tight integration?
- (II) How does this change, as the field matures?
- (III) What factors can explain such changes?

To address these questions, we use a comprehensive set of comparative-static bibliometric analyses to conduct a longitudinal study of one research field, open source innovation, a fast-growing and supposedly interdisciplinary field. Our analyses rest on several databases of researchers' attributes and co-authoring, publishing and citation behaviors. We analyze 306 core publications on open source innovation and over 10,000 reference documents cited therein.

We find a close and continual relatedness of content, i.e. strong substantive coherence of OS research as a field. However, we find that the substitute preference of interdisciplinary work decreases

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as the field matures. Researchers from different disciplines still study the same topics years into the creation of the field, but do so increasingly from their own disciplinary lenses (co-authoring within their discipline, citing within their discipline, publishing within and for their discipline). Interestingly, we find that “high-involvement” forms of interdisciplinary exchange such as co-authoring and cross-disciplinary publishing drop sharply only a few years after the inception of the research field. “Low-involvement forms” such as cross-disciplinary citations are slower to decline.

We propose, based on extant studies of other fields, that the pattern we have found in open source research may in fact be quite general: inquiry into a new field often shifts from interdisciplinary to multidisciplinary research, and from joint puzzle solving to parallel problem solving. This pattern may be particularly prevalent among phenomenon-based research fields.

Finally, we explore the contingency factors underlying these patterns. We explain initial high levels of interdisciplinary work as being driven by researchers’ need to draw upon theories or methods established in disciplines other than their own to achieve their research goals (functional dependence). Interdisciplinary functional dependence declines over time, as the understanding of the field increases. Increased understanding enables modularization of further problem solving, often within disciplinary boundaries. Moreover, we argue that task uncertainty declines over time, and that expanding research fields enable researchers to deploy lower-cost strategies of accessing knowledge from other disciplines.

Our paper contributes to the literature in several ways. First, we propose a set of bibliometric tools that allows a comprehensive assessment of the cohesion of research fields. For any field, cohesion among disciplines, but also among geographies or schools of thought, can be studied from multiple angles by applying this set of tools.

We advocate using more than one publication database (e.g. Google Scholar, Ebsco, and the Institute for Science Information (ISI) database) and show that the common practice of using just one source may come at the cost of a substantial loss of relevant data.

Next, we apply this tool-set in one case, which future work on interdisciplinary research can use as a reference case. Our bibliometric findings relating to our specific case, the thriving field of open source research, are relevant to scholars interested in that field as well as to scholars interested in the emergence of successful new research fields.

Further and more generally, we theorize how changes in three underlying variables affect the disciplinary nature of research undertaken in a field at any point in time. We advance testable propositions that can guide future research. Our findings have important implications for individual researchers, research organizations, and research funding policies that seek to design and promote optimal research strategies, and to science media that assess and publish scholarly work.

The remainder of the paper is structured as follows: Section 2 describes prior related research and outlines important gaps. Our research methodology and data collection are explained in Section 4, the main findings section, we analyze the coherence of the OS field, and its change over time, along multiple dimensions. In Section 5, we consider the generality of our bibliometric findings and advance propositions to explain them. Finally, Section 6 discusses the contribution of this paper in relation to prior research and derives implications for future research, practice and policy.

2. Prior research and research gap

2.1. Background and definitions

A scientific discipline is “a specialized field of knowledge” (Chubin et al., 1986a). Disciplines “represent historical,

evolutionary aggregates of shared scholarly interest,” which typically gain legitimacy in a university as departments (Chubin et al., 1986a, p. 4). Throughout this paper, when referring to disciplines, we mean aggregations as represented in university departments, e.g. management studies, psychology, or law. Following Qin et al. (1997, p. 894), we define interdisciplinary research as “the integration of disciplines within a research environment.” This integration consists of interactions among scientists (possibly mediated by their research outputs) and is motivated by a common problem-solving purpose.

A research field, or specialty, is an area of science that is defined by its intellectual coherence as well as its social coherence (Chubin, 1976, p. 451). Research fields cluster around ‘central problems’; they address specific and recognizable sets of questions (Darden and Maull, 1977).

Building on groundwork laid by Kuhn (1962), Merton (1973), and Chubin (1976), among others, many scholars study the emergence and evolution of new research fields (Bonaccorsi and Vargas, 2010). They find that new research fields often (but not always) form around a puzzling phenomenon that deviates from what theory tells us to expect (Davis, 1971; Christensen, 2006). The goal is to distinguish, describe and theorize the puzzling phenomenon (von Krogh et al., 2012b).

Chubin (1976) suggests that new research fields tend to fall between research disciplines and that core researchers advance their field by drawing inspiration and insight from its margins (cf. Dogan and Pahre, 1990). As a consequence, researchers in new fields, and in phenomenon-based ones in particular, often have shared interests but different educational backgrounds (Chubin, 1976; Birnbaum, 1981; Gibbons et al., 1994). With sometimes very little common ground among them, they need to create a shared set of concepts, goals, and norms – a liability that phenomenon-based fields have often struggled with (Merton, 1973).

Some new research fields attract so much immigration and make findings that are so distinct from researchers’ home disciplines, that a new discipline begins to emerge. (Such was the case for material science, for instance, that did not disintegrate back into metallurgy and ceramics.) In most cases, however, cross-disciplinary research fields remain narrower, more or less formalized, and sometimes long-lasting, “hybrids” (Dogan and Pahre, 1990). Our paper focuses on such hybrids and their evolution, arguing that they may be inherently unstable.

2.2. Overview of related literature

Many scholars argue that, in order to extend our understanding of the evolution of emergent new research fields, it is important to study how scholars jointly create and recombine knowledge within and across disciplines (Birnbaum, 1981; McCain, 1998; Hessels and van Lente, 2008; Tsai and Wu, 2010). Our contribution builds on three streams of literature:

(1) A number of studies conduct comparative-static analyses of particular research fields. E.g., for the field of strategic management, Ramos-Rodríguez and Ruíz-Navarro (2004) and Nerur et al. (2008) find that different time periods exhibit different co-citation patterns. While the initial stage was more cohesive, subsequent stages showed a greater number of clusters (Nerur et al., 2008). However, these studies do not systematically investigate the disciplinary anchoring of the authors and their works, nor intend to generalize from such findings (one exception being, e.g. Ponzi, 2002).

(2) Another and mostly distinct literature rooted in information science and library science investigates interdisciplinarity, its measurement, prominence, costs and benefits, and organizational practices (see <http://transdisciplinarity.ch/e/for-an-extensive-bibliography>). These studies mostly remain at the macro/meso levels, focusing on disciplines, subject categories and

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