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Scientific teams: Self-assembly, fluidness, and interdependence

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ABSTRACT

Science is increasingly produced in collaborative teams, but collaborative teams in science are self-assembled and fluid. Such characteristics call for a network approach to account for external activities responsible for team product but taking place beyond closed team boundaries in the open network. Given such characteristics of collaborative teams in science, we empirically test the interdependence between collaborative teams in the same network. Specifically, using fixed effects Poisson models and panel data of 1310 American scientists' life-time publication histories, we demonstrate knowledge spillovers from new collaborators to other teams not involving these new collaborators. Our findings have important implications for studying the organization of science.

1. Introduction

Scientific knowledge is increasingly created collaboratively, as reflected in the increasing share of coauthored papers and the growing size of collaborative teams (de Solla Price, 1986; Hicks & Katz, 1996; Wuchty, Jones, & Uzzi, 2007). This increase in collaboration is driven by a variety of factors, such as the importance of interdisciplinary research questions, growing specialization and the consequent gains from division of labor, new information and communication technologies, and the need to develop and access large shared equipment and large databases (de Solla Price, 1986; Katz & Martin, 1997; Stephan, 2012). Because of the prevalence of collaboration in science, the collaborative team has become an important unit of analysis for studying the organization of science. Accordingly, scholars have extended science studies and laboratory ethnographies from lab benches to *collaboratories* (Chompalov, Genuth, & Shrum, 2002; Cummings & Kiesler, 2005; Shrum, Chompalov, & Genuth, 2001). In addition, by bringing in insights from the psychology literature on small groups and the sociology literature on work organizations, scholars have made significant contributions to the *science of team science* (Falk-Krzesinski et al., 2010; Fiore, 2008; Stokols, Hall, Taylor, & Moser, 2008). For example, scholars have investigated the structure and process of collaborative teams, and their effects on team productivity and creativity (Cummings, Kiesler, Zadeh, & Balakrishnan, 2013; Hemlin, Allwood, Martin, & Mumford, 2013; Lee, Walsh, & Wang, 2014; Levine & Moreland, 2004).

Before this recent emergence of the *science of team science*, research on teams has a long history in the social psychology literature (Guzzo & Dickson, 1996; Levine & Moreland, 1990; McGrath & Kravitz, 1982). The management literature has

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also investigated teams extensively in the corporate world, as cross-functional project teams are increasingly adopted by companies to couple with the rapidly changing and competitive environment (Denison, Hart, & Kahn, 1996; Keller, 2001; Pearce & Ensley, 2004).

Teams in the real-world operate in various settings and undertake different structures and dynamics. Therefore, scholars have updated the traditional view of teams. For example, the *external approach* emphasizes team behavior directed toward the external environment, rather than assuming teams as isolated and independent from the external environment (Ancona & Caldwell, 1988; Ancona & Caldwell, 1992; Ancona, 1990). The *virtual team* literature investigates teams with geographically dispersed members and predominantly coordinated via electronic media (Hertel, Geister, & Konradt, 2005; Lipnack & Stamps, 1997; Townsend, DeMarie, & Hendrickson, 1998), as opposed to the earlier view of teams as small, collocated, and cohesive entities with intense face-to-face interactions. Research on open source software teams highlights that these teams are voluntary-based and fluid, different from the traditional teams with relatively clear and stable boundaries, functions, roles, and norms (Aime, Humphrey, Derue, & Paul, 2014; Bagozzi & Dholakia, 2006; Hertel, Niedner, & Herrmann, 2003).

Wellman (1997) argued that some teams are tightly-bound, clearly-delimited and densely-knit, while other teams ramify like an expanding spider's web. The latter is more suitably studied as an open network instead of as a traditional team with clear and stable boundaries. Collaborative teams in science clearly fall in the second category. Following Wellman (1997), this paper argues that the network approach is especially important for studying the organization of science. Specifically, this paper first discusses special characteristics of teams in science, that is, teams in science are self-assembled and fluid, and therefore it is important to incorporate a network approach when studying scientific teams. Contributing to the understanding of the complexity in scientific teams, we develop empirical strategy to test the dependence of teams on networks, specifically, the knowledge spillover across coauthor teams linked by a single scientist. The *organizational learning* literature has long emphasized newcomers as important sources of innovation in organizations (Gupta, Smith, & Shalley, 2006; March, 1991; Perretti & Negro, 2006), we further hypothesize that a scientist's new collaborators would also contribute to the citation performance of his/her other papers not coauthored with these new collaborators. The confirmation of this hypothesis provides empirical evidence of the dependence of collaborative teams on other scientists and teams, and such dependence has important implications for investigating the organization of science.

2. Teams in science: definition and characteristics

The literature has defined teams in various ways. Following Guzzo and Dickson (1996), we define a *team* as "made up of individuals who see themselves and who are seen by others as a social entity, who are interdependent because of the tasks they perform as members of a group, who are embedded in one or more larger social systems (e.g., community, organization), and who perform tasks that affect others (such as customers or coworkers)." (pp. 308–309). More specifically, we focus on the ad hoc teams in science assembled for a specific project, with members from different organizations and locations. Such teams differ from formal academic organizations such as departments or laboratories, which are sometimes referred to as teams. Ad hoc project teams in science have unstable memberships and ill-defined boundaries, causing a lot of problems for those attempting to operationalize teams for empirical studies (Haeussler & Sauermann, 2013; Katz & Martin, 1997; Laudel, 2002). Therefore, we adopt two definitions in this paper: (1) a *collaborative team* defined broadly as the group of researchers contributing to a scientific project, which is often hard to identify since some members may not be listed as authors of the final publication, and (2) a *coauthor team* defined narrowly as the group of authors taking credits for the publication. We will discuss the gap between these two definitions and how a network approach is important to mitigate such problems in team studies.

Science has many distinct features compared with other systems of work organization (Whitley, 2000), and collaborative teams in science have many special characteristics which may challenge the traditional view of teams. One important characteristic distinguishing science from other systems of work organization is its autonomy and self-governance. Collaborative teams in science are largely voluntary and based on mutual interests, and scientists have substantial autonomy to create, maintain, restructure, and dissolve their collaborative teams. This paper focuses on two characteristics: self-assembly and fluidness. First, collaborative teams in science are self-assembled. In traditional team studies, teams are assembled first (and most likely assembled by managers or researchers rather than by team members themselves) and then undertake the complete group process which results in the final team outcome, so researchers can treat team characteristics as exogenous variables and investigate their effects on team performance (Cohen & Bailey, 1997; Hulsheger, Anderson, & Salgado, 2009; Stewart, 2006). However, for self-assembled teams nothing is exogenous (Contractor, 2013; Lungeanu, Huang, & Contractor, 2014; Zhu, Huang, & Contractor, 2013). Projects are both the result and the cause of the team (Zhu et al., 2013). In other words, the process of idea generation precedes or co-evolves with the process of team assembly, and the creative process underlying the final team product starts in the open network before the team is assembled.

Second, collaborative teams in science are fluid, that is, with ill-defined boundaries and unstable memberships. Because of the autonomy in organizing teams, people constantly come and go. For example, collaborative teams may acquire new members when new expertise is needed, and team members may leave the team as they no longer share the common interest with other teammates. To some extent, a collaborative team is co-evolving with the project, and there is rarely a stable team seeing through the whole creative process, such as idea generation, convergence, and implementation (Hackman & Morris, 1975; Levine & Moreland, 2004; Skilton & Dooley, 2010). This fluidness is also magnified by another feature that distinguishes science from other types of working environment, that is, high task uncertainty and continual novel production