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Human capital heterogeneity, collaborative relationships, and publication patterns in a multidisciplinary scientific alliance: a comparative case study of two scientific teams

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Abstract

In this paper, we compare the publication outcomes of two teams within a multi-university scientific alliance. Scientists in one team share similar scholarly backgrounds and work in a well established paradigm, while scientists in the second team have different backgrounds and work in an emergent discipline. While the alliance has increased the productivity of both teams, this increase was highest for the more heterogeneous team. In addition, while the variety of knowledge concepts employed in their research was initially higher for the heterogeneous team, this gap narrowed over time. We discuss the implications of our research for alliance design.

Keywords: Alliance; Knowledge; Human capital; Collaboration; Multidisciplinary

1. Introduction

Science has become increasingly collaborative during the past several decades, and many new organizational forms have emerged to manage collaboration among scientists in productive ways (e.g., Chompalov et al., 2001). In their review of the literature on scientific collaboration, Katz and Martin (1997) argued that collaboration has been spurred by changing patterns of research funding, the professionalization of scientific personnel, the need to pool resources to address increasingly complex and expensive research questions, progressively more specialized scientific disciplines, new communication technologies, and the desire of researchers to enhance their professional visibility and productivity. While empirical research does indeed suggest that scientific collaboration has many desirable outcomes (e.g., Katz and Martin, 1997), it is also

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clear that collaborative work is difficult, expensive in both time and money, and entails non-trivial problems of coordination and communication among sometimes diverse scientists that can undercut even the best of intentions (e.g., Williams and O'Reilly, 1998; Reagans and Zuckerman, 2001). In short, collaboration is very much a "double-edged sword," (Milliken and Martins, 1996), and this double-edge becomes increasingly sharp as firms, universities, and governments spend billions of dollars each year to fund large scale interdisciplinary projects to expand the frontiers of knowledge. It thus becomes desirable, from both a policy and theoretical standpoint, to understand the dynamics of collaborative forms of scientific work and the key tradeoffs that such work carries with it.

One form of cooperative endeavor that has become increasingly important in scientific research and development is the interorganizational alliance (e.g., Gulati et al., 2000; Powell, 1990). Alliances are voluntary arrangements between two or more organizations involving "exchange, sharing, or co-development of products, technologies, or services" (Gulati, 1998). Strategic alliances can be formed at many different organizational levels, and at many different positions along an organization's value chain. One common use of alliances, however, is to connect the research and/or development functions of two or more organizations in an attempt to capture the benefits of combining the scientific and technological assets of the alliance partners (e.g., Powell et al., 1996; Hagedoorn, 1993). The most important assets in this regard are the stocks of specialized knowledge possessed by each partner organization. The motivation behind most alliances is to create the conditions for organization-specific knowledge to be transferred across organizations and combined in ways that lead to varied insights that would not be possible if each organization were pursuing research and development activities on its own.

While research alliances and partnerships are perhaps most prevalent among private sector firms pursuing joint R&D activities (e.g., Hagedoorn et al., 2000; Powell, 1990), one important outcropping of the alliance movement over the past two decades has been the formation of scientific alliances among universities intent on sharing and recombining the knowledge of their faculty and research scientists to advance disciplinary and multidisciplinary scientific objectives. Different forms of inter-university collaboration exist in different countries (e.g., Ballesteros and Rico, 2001; Wen and Kobayashi, 2001; Okubo and Sjoberg, 2000), but in the US, university alliances have been spurred, in part, by the availability of government funds from the National Science Foundation (NSF) and other public agencies that have been earmarked for collaborative inter-university research. Good examples of these collaborative endeavors are NSF's Science and Technology Centers focusing on topics such as nanotechnology, adaptive optics, and behavioral neuroscience. Other forms of inter-university collaboration are evident in the NSF sponsored Engineering Research Centers on systems engineering, optoelectronics, and advanced electronic materials processing (e.g., Feller et al., 2002). Each of these endeavors represents a multimillion dollar program of collaboration, usually organized around one or two lead universities, and is focused on the transfer and combination of specialized domain knowledge across university boundaries. As in other types of alliances, the goal of inter-university collaboration is to spur new insights in the domains covered by a particular alliance by bringing together researchers at different universities who otherwise would not, or could not, collaborate in their research.

In this paper, we explore the dynamics of collaborative work in one large government funded scientific alliance incorporating researchers from 35 US universities and government laboratories. The stated purpose of the alliance is to create new scientific knowledge by deploying complex computational modeling and visualization techniques in a variety of disciplines through the use of high performance computing architectures and networks. While the activities of this alliance are quite varied and distributed, the focus of our study is two teams of scientists who were explicitly recruited to develop, explore, and promote high performance computing in their respective disciplines. These research teams vary in the density of their intellectual and social networks. Scientists in one team have longstanding relationships that existed prior to their alliance affiliation; they share similar scholarly backgrounds, and they work in a traditional area of research that is characterized by a well established disciplinary paradigm. Scientists in the second team have much more varied intellectual histories; they come from different scholarly backgrounds, and they work in a new and emerging discipline that is