

ESSAYS ON NETWORK ANTECEDENTS IN A KNOWLEDGE PRODUCTION CONTEXT

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Executive Summary

I. Abstract

This dissertation examines the effects of social networks on an individual's performance and rate of knowledge production. Over three essays, I not only explore how an individual's networks come about, but also how these networks evolve and shape performance outcomes. The first two essays examine how individuals approach the boundary between private and public sectors co-mingled in the scientific knowledge economy. A third paper draws from ecological theory to examine how individual and environmental factors act in concert to shape communication networks. Taken together, this dissertation gives a greater understanding of how networks arise and may be of interest to theorists, empiricists, and managers alike.

II. Introduction

This dissertation is comprised of two complementary streams that both examine how networks arise, evolve, and shape performance outcomes. A large body of empirical evidence suggests that individuals and firms with superior networks reap the benefits of their social relationships. However, it remains uncertain whether better performers lead to more beneficial networks or whether better networks lead to disproportionate performance outcomes. To begin to resolve these issues, my dissertation focuses on the external factors that lead to the formation of an individual's

network. Furthermore, I examine network formation in a setting where the networks themselves are particularly important: the knowledge production context of the life sciences industry.

A first strand of my research investigates how networks shape the boundary between public and private enterprises intertwined in the scientific knowledge economy. A first paper, “Social Influence Given (Partially) Deliberate Matching: Career Imprints in the Creation of Academic Entrepreneurs”, examines how a university scientist’s prior relationships shape their engagement of the commercial sector. What leads a university scientist to begin patenting the fruits of their scientific endeavors? Coauthored with Pierre Azoulay and Toby Stuart, we document the transmission of entrepreneurial norms *inadvertently* transmitted across mentor-trainee dyads.

My coauthors and I suggest that individuals often choose their relationship partners on a small set of dimensions that matter most for that particular relationship. By focusing only on a limited set of partner characteristics, individuals expose themselves to unanticipated social influences because their relationship partners have more interests, attitudes, and preferences than would-be associates considered when they first chose to form their relationship. This implies that some social influences (those dimensions that formed the rationales for the relationship) are endogenous to the matching process, while others (those that are incidental to the formation of the relationship) may be inadvertent. Although we find this atypical model of social influence attractive, it is not an easy idea to test.

We illustrate this notion in a new dataset tracking the training and professional activities of academic biomedical scientists. Using both qualitative and quantitative analyses, we show that scientists-in-training match to their postdoctoral mentors based on two dominant factors: geography and scientific focus. Using a rich oral history archive, we first let the trainees themselves outline the criteria, and concerns that they took into account when matching to postdoctoral mentors. Then for each cohort year, we generate a dyad-level model of trainee-postdoctoral mentor matches, using both observed and counterfactual matches. Both a careful perusal of the oral histories, as well as the dyad-level matching model, failed to suggest that mentors and trainees choose one another along commercial inclinations.

Although we found no evidence that trainees and mentors match on commercial dimensions, trainees then adopt their advisers' orientation toward commercial science as evidenced by the transmission of patenting behavior. We demonstrate this in two-stage econometric models that adjust for the endogeneity of the matching process, using a modification of propensity score estimation and a sample selection correction with valid exclusion restrictions. All three methods – qualitative description, propensity score estimators, and those that tackle selection on unobservable factors – are potential approaches to establishing evidence of social influence in partially endogenous networks, and they may be especially persuasive in combination.

A second essay, “Boundary Spanning in a For-Profit Research Lab: Scientific Publication and the Interface between Commerce and Academe”, examines the public-

private boundary from the perspective of a private firm. The motivating question underlying this paper is why a private firm would choose to make contributions to public knowledge stocks (through publishing). In innovative industries, private sectors firms increasingly are participants in open communities of science or technology. As part of the norms of exchange and engagement in such communities, private firms often publicly disclose what would otherwise remain private discoveries. However, what are the consequences of these public disclosures?

In a qualitative case study of one firm in the biopharmaceutical sector, we explore the consequences of scientific publication—and instance of public disclosure—for a core set of activities within the firm. Coauthored with Toby Stuart, we link publications to human resource practices, finding in researcher-level, fixed-effects regressions that bonuses are tied to publications. Second, using a unique electronic mail dataset, we show that researchers within the firm who author publications are much better connected to external (to the firm) members of the open scientific community. Thus, we provide evidence that publishing increases the reach of a firm's network to university scientists, consistent with the view that publishing increases a focal organization's absorptive capacity. However, in an unanticipated finding, our analysis raises a possible cost to publishing. Prolific publishers have an increasingly extra-organizational focus, resulting in a degradation of internal communication structures. Thus, a firm's prolific publishers begin to migrate to the periphery of the intra-firm social network, which may occur because their strong external relationships induce them to reorient their focus to a community of scientists beyond the firm's boundary.

A second strand of research builds upon ecological theory to examine how individual and environmental factors act in concert to shape communication networks at a biopharmaceutical firm. The third essay draws from ecological theory to examine the precludes to a scientist's communication patterns. Fundamentally, ecologists are concerned with organizations and the environmental resources in which they are embedded. A core ecological concept is the niche, or combinations of resources upon which a focal actor is dependent for its survival. To develop a theory of spatial ecology, I extend the ecological concept of niches to take into consideration the dimension of space. I content that the dominant view about spatial proximity – that high spatial density leads to greater opportunities to expand one's network – is incomplete and potentially misleading. Instead, I argue that the effect of an individual's spatial proximity to others must take into consideration the location and expertise of their colleagues.

In the third essay, I turn from the boundary between public and private sectors in the scientific knowledge economy to the determinants of communication patterns within a biotechnology firm. This paper, "A Spatial Ecology of Structural Holes: Scientists and Communication at a Biotechnology Firm", contends that the prevailing view about spatial proximity – that high spatial density leads to greater opportunities to expand one's network – is at best incomplete and potentially misleading. Instead, I argue that an individual's spatial proximity must be considered in an ecological context – i.e., in relation to the location and expertise of proximate colleagues. Close spatial proximity to colleagues who have significantly overlapping expertise to the focal individual, can inhibit an individual's ability to expand one's network. As a result, spatial proximity

along homogeneous individuals results in redundant networks. Co-located individuals, who are very much the same, talk amongst themselves. In clear juxtaposition, I hypothesize that individuals who are distinctive, or physically removed from their social “equivalents”, garner a greater share of external attention and have distinctive, broad networks.

Lastly, physical proximity to individuals who have differing expertise enables an individual’s ability to expand their network through proximate, diverse relationship partners. These proximate, varied clusters lead to diverse networks, consistent with the classic view of agglomeration.

I not only develop a spatial ecological framework, I test these theoretical constructs in the archetype of a knowledge production setting: a biopharmaceutical firm. Using a unique dataset of email communication patterns, fine-grained blueprints of office-locations, scientific publication keywords, as well as the formal organization chart of a biotechnology firm, I find that co-location alone is not associated with an individual’s ability to form broad, expansive networks. In fact, spatial proximity to workgroup (i.e., same laboratory) members inhibits an individual’s ability to form networks that reach across an organization. By contrast, spatial proximity to non-workgroup (i.e., different laboratory) colleagues is associated with having broader networks. Lastly, these environmental factors are large, commensurate with an individual’s stock of human capital (e.g., general and firm-specific knowledge). This paper contributes to the literature on networks and the organization of innovative work by

developing a theory of spatial ecology and demonstrating its connection to network structural features that have been repeatedly linked to superior performance in knowledge production contexts.

VI. Conclusion

Taken together, these papers not only make contributions to the literature on networks and the organization of innovative work, they return attention to the key role of geography in both enabling and constraining an individual's opportunities and relationships. The first chapter, "Social Influence", illustrated how geographic proximity serves as a critical determinant in matching between mentor-trainee relationships. The second chapter, "Boundary Spanning", suggests a mechanism by which intra-organizational scientists may increase the breadth of their social connections. Lastly, the third chapter "Spatial Ecology" addresses the central role that geography plays in shaping communication patterns, albeit in surprising ways.

Both research streams are situated in the life sciences sector, an archetype of a knowledge-production environment. Not only has this dissertation spoken to the social scientists, but to managers at biotechnology and pharmaceutical firms, as well as other knowledge production settings. Furthermore, this dissertation builds upon my prior training as a molecular biochemist. Given my unique background, I bring rich expertise in both the technological and cultural context of scientific knowledge production, as well as access to privileged data sources through my scientific network. Lastly, I have found to my surprise and delight, that a biological intuition may lend insight into the study of

organizations and organizational theory. My ideas and dissertation research have been indelibly shaped by paradigms from the life sciences, and I relish the opportunity to continue to draw from this knowledge base in the future.

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