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The spill-over theory reversed: The impact of regional economies on the commercialization of university science

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ABSTRACT

The concept of regional technology spill-overs created by university research is one of the most enduring theories within the economic geography and innovation management fields. This article introduces an alternative perspective on academic commercialization, arguing that the quality of a university's regional environment can significantly impact a university's success in commercializing science. Recent research on university technology transfer stresses the importance of personal contacts between academic and industry scientists in driving commercialization. The social structure of the regional economy in which a university is embedded will strongly influence the density of contacts linking university scientists with individuals in industry, and through doing so, impact the density of networks through which university knowledge can be commercialized. Social network analysis is used to examine the quality of social ties linking industry and university scientists within the San Francisco and Los Angeles California biotechnology industries over the 1980–2005 period. Results support the theory that the existence of strong social networks linking inventors heightens university commercialization output. Despite similar university research endowments, universities in San Francisco have dramatically commercialization outputs than San Francisco, which is correlated with the existence of cohesive inventor networks linking industry and university scientists in this region, but not Los Angeles. Moreover, longitudinal analysis shows that the commercialization output of San Francisco universities increased substantially starting in the early 1990s, the time period in which cohesive inventor networks emerged in the region.

1. Introduction

The concept of regional technology spill-overs created by university research is one of the most enduring theories within the economic geography and science and technology study fields. While scholars had long viewed basic research as a public good that could spill-over into society (Arrow, 1962; Rosenberg and Nelson, 1994, 1996), the recognition that knowledge being developed in universities is often tacit or "sticky" (Von Hippel, 1994) lead to a wave of research viewing universities as anchors of regional economic development (see e.g., Audretsch and Feldman, 1996, 2003; Jaffe et al., 1993). Firms have an incentive to locate near universities, as proximity to universities reduces the cost of accessing and absorbing knowledge spill-overs (Audretsch and Lehmann, 2005, p. 1115). The process by which university knowledge leads to the creation of regional spin-off companies has also been intensely studied, both in terms of the importance of such firms to economic growth (see e.g. Florida and Choen, 1999) but also the creation of regional technology clusters (Braunerhjelm and Feldman, 2006; Audretsch and Lehmann, 2005). Universities have been heralded as "engines of growth" (Florax, 1992). Economic development has become a "third mission" of universities (Etzkowitz, 2002), complementing education and basic research, and is also frequently used to justify public investments in university research (see Hage, 2011; National Academies, 2007).

The management of university knowledge spill-overs has become a central issue within the field of technology transfer studies. The enactment in the United States of the 1980 Bayh–Dole Act legitimated the idea that university research should be treated as intellectual property that can be commercialized, and in most cases transferred ownership of federally funded research to the university in which it was conducted (see Mowery et al., 2004). Though controversial (see Kenney and Patton, 2009), the Bayh–Dole framework has become emulated in the UK, Japan, Germany, and many other nations around the world (Mowery and Sampat, 2005). Much research on academic commercialization has focused on variation in the ability of universities to successfully commercialize technology. Scholars have identified a range of factors internal to universities linked to effective technology transfer. These include the quality of a university's basic research endowments (Powers and McDougall, 2005), the university's prestige (Sine et al., 2003),

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and organizational practices and funding surrounding technology transfer (Siegel et al., 2003; O'Shea et al., 2005).

This article introduces an alternative perspective on academic commercialization, arguing that the quality of a university's regional environment can significantly impact a university's success in commercializing science. While the idea that university research can usefully flow into regional economies is not contested, the mechanisms structuring this flow are. While most research on academic commercialization emphasizes "push" variables – seen by the predominance of internal factors in explaining success in commercialization – this article argues that "pull" factors can be equally important. Recent research within the technology literature emphasizes the importance of personal contacts between academic and industry scientists in driving commercialization (Thursby and Thursby, 2004). The quality of the regional economy in which a university is embedded will strongly influence the density of contacts linking university scientists with individuals in industry, and through doing so, structure the existence of networks through which university knowledge can be commercialized.

There is a long tradition of economic geographers and sociologists comparing the social and industrial organization of regional economies (see e.g. Storper, 1997; Piore and Sabel, 1984). Economic sociologists argue that the fabric of social ties within regions strongly impacts the pattern by which individuals working within companies, universities, and other organizations interact (Saxenian, 1994; Herrigel, 1993). Regional factors can influence the R&D strategies of companies, and through doing so structure the organization of inter-organizational ties linking scientists and engineers within regional economies. Walter Powell and collaborators have made particularly important contributions to this approach, emphasizing the importance of social networks at both the individual and organizational level in impacting the performance of firms within biotechnology and other science based industries (Owen-Smith and Powell, 2004; Powell et al., 1996, 2002, 2005a,b). Powell's research was the first to employ social network methods to map networks across both firms and individuals within the biotechnology field, generating direct evidence that the structure of social ties both varies regionally and impacts the performance of firms within science-based industry.

This article contributes to Powell's general strategy of mapping social networks linking scientists, engineers, and entrepreneurs within regional biotechnology clusters, applying the approach to university commercialization. The article argues that university scientists are likely to develop pervasive networks of contacts with industry scientists when they work at a university embedded within a regional economy in which local industry adopts technology strategies that encourage collaboration with university scientists. Universities embedded within regions that either lack a significant industry presence or one in which companies have developed primarily inward looking R&D strategies will not develop extensive networks of ties linking academics with industry, and as a result will have lower commercialization output. In this sense, the perspective offered here reverses the causal mechanism commonly associated with spill-over theory: technology is more likely to flow from universities to a regional environment when the 'plumbing' – or network of contacts between university and industry scientists – is in place to pull knowledge from universities into the regional economy.

The article uses social network analysis to examine the quality of social ties linking industry and university scientists within the San Francisco and Los Angeles California biotechnology industries over the 1980–2005 period. Drawing on data from close to 20,000 biotechnology patents, it maps the emergence of networks linking inventors in San Francisco and Los Angeles. This data is then used to explore whether the existence of cohesive inventor networks that connect university and industry scientists within a region is correlated with increased commercialization output from local universities.

To preview the article's findings, the San Francisco and Los Angeles cases support the theory that the existence of strong social networks linking inventors heightens university commercialization output. San Francisco has developed a large, cohesive network linking thousands of biotechnology inventors, into which hundreds of university scientists have become connected. This network developed incrementally between 1980 and 2005 and only became highly interconnected in the post-1990 period. The academic commercialization output of universities located within the San Francisco region increased substantially in the post-1990 period, after a cohesive social network linking inventors emerged. Moreover, two universities whose scientists developed particularly strong linkages within regional industry inventor networks, Stanford and the University of California San Francisco, saw the largest increases in commercialization output. In the Los Angeles region, in contrast, the biotechnology industry has not developed a large or cohesive inventor network, with the consequence that fewer ties linking university and industry scientists have developed. Universities in the region, despite having comparable resources to those in the San Francisco region, have a much lower commercialization output.

2. The quality of regional environments and academic commercialization

This article argues that organization of inter-organizational social ties among scientists within a university's regional economy can influence commercialization patterns. This argument has two elements. First, drawing on recent research within the technology transfer studies field (Thursby and Thursby, 2004; Kenney and Patton, 2009; Lam, 2007), it is argued that personnel ties between university and company personnel are an important driver of academic commercialization. Second, focusing on contributions from economic sociology (Saxenian, 1994; Piore and Sabel, 1984; Powell et al., 1996, 2005a,b), it is claimed that the social organization of regional economies shape the development of inter-organizational networks linking scientists and engineers. Regions that develop dense social networks across inventors will foster more numerous personnel ties linking local companies and university scientists compared to regions that do not, increasing the potential for commercialization processes to develop within the region.

Recent research within the technology transfer literature has emphasized the importance of personal contacts linking industry and academic scientists in driving forward university commercialization. Thursby and Thursby (2004), in discussing the origins of university technology licensing agreements, emphasize the "extreme importance of personal contacts between the firm's R&D staff and university personnel." Their survey of over a hundred companies that had initiated technology licensing arrangements with universities found that 45.7% of companies cited personal contacts as "extremely important" and a further 31.4% of respondents cited contacts as "important" (Thursby and Thursby, 2004, p. 169). Kenney and Patton (2009) also emphasize the key role of university scientists in driving technology commercialization. Compared to licensing officers, faculty have superior knowledge of the technology and broader research field, and often have pre-existing contacts to companies that can be crucial in easing concerns on the part of the company that a university technology, once licensed, can be successfully transferred (Kenney and Patton, 2009, p. 1411). Lam (2007), in a study of several university–industry relationships in the United Kingdom, has emphasized the role of "linked" university scientists, defined both in terms of translational research interests