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Vertical alliance networks: The case of university–biotechnology–pharmaceutical alliance chains

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Abstract

Many young biotechnology firms act as intermediaries in tripartite alliance chains. They enter upstream partnerships with public sector research institutions, and later form commercialization alliances with established, downstream firms. We examine the alliance activity in a large sample of biotechnology firms and find: (i) firms with multiple in-licensing agreements are more likely to attract revenue-generating alliances with downstream partners; however, (ii) the positive relationship between in-licenses and downstream alliances attenuates as firms mature, and (iii) the diversity and the quality of the academic connections of firms' principals influences their chances of successfully acquiring commercialization rights to scientific discoveries in universities.

Keywords: Strategic alliance; Biotechnology industry; Brokerage; Social networks; Technology transfer

1. Introduction

In the growing literature on inter-corporate partnerships at the nexus of strategic management, organizational theory, and organizational economics, biotechnology has emerged as perhaps the most frequently examined research site. This is unsurprising given the seemingly inexhaustible incidence of alliance formation in the sector (Hagedoorn, 1993). Studies of alliances in the biopharmaceuticals industry have generally pursued one of three broad research objectives. First, the industry has hosted a number of studies that test theories of alliance formation (e.g., Barley et al., 1992; Powell et al., 1996; Walker et al., 1997). Second, researchers have explored the deal-specific and competitive conditions that engender governance choices in alliance agreements, such as the decision to take a partial ownership stake in a partner (e.g., Pisano, 1989, 1991; Robinson and Stuart, 2007). Third, a number of studies have gauged the consequences of collaborative activity for firm-level performance outcomes, including the rate of innovation (Shan et al., 1994), growth (Powell et al., 1996), valuations of early stage companies (Stuart et al., 1999), and the adaptability of established organizations (Rothaermel, 2002).

It is well understood that the majority of alliances in the biotechnology sector are vertical: many collaborations unite the efforts of two organizations that, at least under the parameters of the alliance contract, engage in relatively distinct sets of activities along the value chain in the life sciences. In the types of deals that have garnered the most attention in the academic literature, a biotechnology firm conducts research and development and transfers the output(s) to a pharmaceu-

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tical or life sciences company, which then undertakes additional development and the marketing of any resulting products (see, for example, Pisano, 1989; Reuer et al., 2002; George et al., 2002; Robinson and Stuart, 2007). In the language of Teece (1986), biotechnology firms often have expertise in the development of novel scientific approaches to drug development, while the complementary assets to advance and ultimately commercialize these technologies reside in pharmaceutical firms. Although the actual relationship between partners is more iterative and interactive than this simplistic characterization suggests, biotechnology alliances often entail a vertical division of labor along a value chain, rather than horizontal linkages among firms engaged in similar activities.

Much of the existing literature on strategic alliances implicitly locates biotechnology firms at the upstream pole of the pharmaceutical (or agricultural biotechnology) industry value chains. In other words, biotechnology firms are understood to be originators of technology, which is then eventually brought to the marketplace by strategic alliance partners with extensive marketing organizations and experience in managing the clinical trials process (e.g., Barley et al., 1992; Rothaermel, 2001; Rothaermel and Deeds, 2004; Robinson and Stuart, 2007). This is a fair characterization of many alliances in the industry. However, as a different body of work on the origins and evolution of biotechnology firms has illuminated, many biotech firms maintain close links with universities (see for example, Liebeskind et al., 1996; Audretsch and Stephan, 1996; Powell et al., 1996; Zucker et al., 1998; George et al., 2002; Murray and Stern, in press). Indeed, with just a handful of exceptions, the drugs on the market today with biotechnological origins have emanated from license agreements for scientific discoveries made in universities (Edwards et al., 2003). Given the multiplex relationship between biotechnology firms and universities, the primary question we address here is: how do the extensive, formal interactions between these two types of organizations influence the dynamics of downstream alliance activity in the industry? We also explore a secondary question: to what extent is the propensity to in-source university science a function of the within-academe networks of the founders and scientific advisors of the biotechnology firms? In other words, in this paper we treat biotechnology firms as the unit of analysis and analyze their rates of formation of upstream-oriented alliances with universities and downstream-focused transactions with established firms.

We hypothesize that one of the most significant roles performed by biotechnology companies has been to identify and in-license science created in universities, and then to further develop and ultimately transfer this intellectual property to larger firms that possess the resources to commercialize the technology. Thus, although virtually all biotechnology firms conduct substantial internal research and most add value to the technologies they in-license, these organizations often perform the role of value-added intermediaries in the migration of intellectual property from universities to downstream strategic partners.[1] We draw upon the literature on brokerage and intermediation in technology development to formulate predictions about the dynamics of the tripartite alliance chains that emerge as scientific discoveries progress from universities to biotechnology firms, and then to the established firms located further down the value chain.

Although our analysis will be situated in the biotechnology sector and we will refer to conditions in the industry while formulating the predictions, we believe that the arguments we develop are relevant to other, science-driven high-technology industries, including subfields in microelectronics, advanced materials, and the emerging area of nanotechnology. The more general value of the analysis in the paper is to explore the correlates of an increasingly prevalent business model: young technology firms with close ties to research institutions acting as intermediaries in alliance chains that lead to the development and commercialization of science-based discoveries originating in public sector organizations.

The paper contains three primary findings. First, we show that biotechnology firms with a greater number of in-license agreements with universities are more likely to craft revenue-generating alliances with downstream partners. This is the core relationship we seek to confirm: if young biotechnology firms are technology brokers, firms with many university deals will have more to offer to downstream partners in strategic alliances. However, we also hypothesize – and find – that the positive relationship between upstream and downstream alliances attenuates in biotechnology firm

[1] Following convention, we will refer to technology sourcing alliances between biotechnology firms and universities as "upstream" partnerships, and alliances between biotechnology firms and established life sciences companies as "downstream" deals. Thus, throughout the paper, we will use upstream and downstream to designate the direction of an alliance relative to a biotechnology firm's position in the industry's value chain. Also, we interchangeably use the terms "life sciences" and "pharmaceutical" firm to refer to the downstream partners that collaborate with biotech firms. These firms include, in order of frequency, pharmaceutical companies (e.g., Eli Lilly), mature biotechnology firms (e.g., Amgen), and agrochemicals firms (e.g., Dupont, Monsanto). Finally, throughout the paper, we will use the term "broker" and "intermediary" as synonyms.