THE EFFECT OF A BIOTECHNOLOGY SMES' NETWORK POSITION ON ITS INNOVATIVE PERFORMANCE

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ABSTRACT- This research paper studies the importance of an SME's network position within the biotechnology industry, and the effect of it on its innovative performance. We developed theoretical propositions departing from the resource based view and network theory. We argue that a firm's position within an SME network will have an influence on the innovation output. The more R&D collaboration a small biotech firm has with other SMEs in the biotech sector, the greater the subsequent innovation output of the firm. We also argue that centrality within the network matters. These propositions will be tested using a dataset we are constructing. We used the MERIT-CATI database to select companies that formed inter-firm R&D collaborations during the period 1990-2000 in the pharmaceutical biotechnology industry. We are linking innovation measures to the firms of these R&D alliances.

1. Introduction

This research paper studies the importance of an SME's network position within the biotechnology sector, and the effect of it on its innovative performance. The pharmaceutical biotechnology industry is a rapidly-developing field where the knowledge base is both complex and expanding and the sources of expertise are widely dispersed (Powell, 1998). Firms operating in this sector face two major challenges. First, industries like biotech are characterized by ever-shortening technology development cycles, long product development cycles, but short product cycles. This forms a constant pressure on companies to respond quickly to changing market needs and to new technological opportunities. The survival of the companies depends on the maintenance of a competitive position, which on its turn is determined by the rate of innovation. To stay on top of the field, one has to be at the forefront of knowledge seeking and technology development. (Oliver & Liebeskind,1997). A second challenge is related to the resources and capabilities available to the firm's operating within this industry. Biotechnology is a field where all the relevant capabilities are rarely found under a single organization roof (Powell & Brantley, 1992). While the basic and applied research skills needed to create new products are based in universities, research institutes, and biotech companies, the cash necessary for product development, the experience required in launching extensive clinical trials, and the established, world-wide marketing channels are located in large chemical and pharmaceutical companies. To make up for their lack of internal capabilities, the participants have to turn to cooperation (Powell, 1996).

Small firms within the biotechnology industry are faced with more specific challenges. They have a lot to offer regarding research and new technologies but they lack the competences to commercialize the new drugs successfully. They are often innovative but fail to provide the entire set of business functions along the value chain. They suffer from insufficient management skills and lack production, marketing and production expertise (Shan et al 1994; Powell 1998; Gulati & Gargiulo, 1999, Roijakkers et al 2005, McCutchen & Swamidass, 2004, Audretsch & Feldman, 2003, Pfirrmann, 1998). Most of the small biotech firms are driven by innovations and laboratory discoveries in a single therapeutic area, the resulting cash-flow problems pose severe financial limitations on the companies (Oliver & Liebeskind, 1997). Academic researchers (Senker & Sharp, 1997; McCutchen & Swamidass, 2004; Roijakkers et al 2005; Hagedoorn et al 2005; Powell, 1996; Baum, Calabrese & Silverman, 2000) have illustrated that small biotech firms engage in diverse linkages with large pharmaceutical firms, university and research centres and other small biotech firms to overcome these problems. According to Powell (1996), networks serve as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable.

So far, numerous studies have been published studying alliances between pharmaceutical firms and small biotechnology firms (Senker & Sharp, 1997; McCutchen & Swamidass, 2004; Roijakkers et al 2005; Hagedoorn et al 2005; Han, 2004; Powell, 1996) but only few studies (McCutchen & Swamidass, 2004; Baum, Calabrese & Silverman, 2000) to date have examined the alliances between small biotechnology firms. According to Baum, Calabrese and Silverman (2000) alliances between biotech firms can also provide many of the same benefits as alliances with upstream partners (universities, research institutes and government labs). These alliances provide interaction opportunities that generate new concepts and ideas. Nooteboom (2005, 2000) defines the alliance between biotechnology firms and (public) research institutes as networks of exploration. Alliances between biotech firms could provide the same exploration benefits. As little empirical evidence is available about cooperation between small firms in the biotech industry, this study attempts to fill this gap, by examining R&D alliances established between small biotech firms. Moreover, we study the effect of these linkages on their innovative performance.

The paper is structured as follows. In the next paragraphs a literature review is presented and hypotheses are formulated. This is followed by a description of the research methods and procedures used in the study. The results are then discussed. Finally, implications, limitations, and directions for future research are offered.

2. Theoretical development

Academic publications studying cooperation between biotech firms have used different theoretical perspectives. The traditional theoretical answer to the explanation of cooperation motives has been transaction cost theory (Eisenhardt & Schoonhoven, 1996). However, this perspective does not capture many of the strategic advantages of alliances such as learning (Powell, 1996) and the creation of legitimacy (Baum and Oliver, 1991). Other theories used to explain cooperation between these firms are the resource-based and network theory. Within resource-based theory, firms are seen as bundles of resources. These resources can be tangible or intangible (Eisenhardt & Schoonhoven, 1996). Cooperation is described as an option to get access to scarce or complementary resources (Baum, Calabrese & Silverman, 2000; Roijakkers et al, 2005, Powell, 1998) In network theory, a basic assumption is that economic exchange is embedded in a particular structure (Powell, 1990). Being embedded in a network can bring numerous advantages for firms. The companies get access to enhanced resources, the risk can be shared and costs can be reduced (Rothwell, 1991). According to Larson (1992) a network is a flexible alternative to integration.
We will be using both these theoretical foundations to construct our propositions on R&D alliances established between small biotech firms.

2.1 Resource based view

According to the resource based view, firms can be seen as bundles of resources; different firms possess different bundles of these resources. If firms are doing well in an industry, this can be explained by their internal resources and accumulated capabilities (Barney, 1991).
If firms want to fully exploit their stock of resources and if they want to develop a competitive advantage, it could be necessary to acquire complementary resources externally (Grant, 1991). This is especially the case in high-tech industries where the sources of knowledge are widely dispersed like the biotech industry (Powell, 1998). In recent years, we witnessed an enormous growth of strategic alliances and other forms of collaboration within

this industry (Baum, Calabrese & Silverman, 2000; Hagedoorn & Schakenraad, 1994, Powell, 1998).
The effect of alliances on the performance of collaborations in the biotechnology industry is already been studied (e.g. Deeds & Hill, 1996; Liebeskind, Oliver, Zucker & Brewer, 1996; George et al, 2001).
By engaging in R&D alliances, high technology firms get access to different resources like new knowledge (Powell, Koput, & Smith-Doerr, 1996). This enhances innovation and product development (Deeds & Hill, 1996). By forming an alliance with universities or public research centres, biotech firms get access to up-to-date information (Liebeskind et al., 1996). According to Baum, Calabrese and Silverman, (2000), alliances between biotechnology firms bring the same advantages as alliances between biotech firms and universities and research institutes. One might conclude that firms that do not cooperate or cooperate less with other companies, will be less innovative. This formulation leads to the following proposition:

Proposition 1 : The more a small- and medium sized biotechnology firm is engaged in R&D alliances with other Biotech SMEs, the greater the subsequent innovation output of the firm.

Eisenhardt and Schoonhoven (1996) mention that in order to get resources, firms must have resources. Resources can be divided into four categories: financial capital, physical capital, human capital, and organizational capital. Small firms (less than 500 employees) have less resources and therefore are less likely to engage in R&D collaborations. Hence,

Proposition 2: The smaller the biotech firm, the less R&D collaborations with other biotech SMEs it will have.

2.2 Network theory

In the biotechnology industry the knowledge base is complex and expanding and the sources of expertise are widely dispersed. Few innovations can be assigned to a specific firm (Powell, 1998; Powell et al., 1996), as innovation requires the convergence of many sources of knowledge and skills, usually linked in the form of a network (Salman & Saives, 2005).
Several studies have indicated that the positions of firms in interorganizational networks influence firm behaviour and outcomes (Powell et al., 1996; Walker et al., 1997).
In order to describe the position of a firm in a network, we will be using ‘centrality’. Network centrality is a measure to indicate which organizations are the key in the flow of information and exchange of knowledge within the network (Salman & Saives, 2005).
According to Powell et al, centrally located firms have access to a greater variety of activities and are better able to locate themselves in information rich positions. Centrality increases the volume of patenting, non operating income, and sales. More central located actors will have sooner access to new important developments and will receive new information earlier. Hence,

Proposition 3: The more central the biotech SME is located within the network, the more innovative the firm will be.

March (1991) makes the distinction between two kinds of networks, namely networks of exploration and networks of exploitation. Exploration is characterized by radical innovations. It changes fundamental architectures, logics or principles of the technology. According to

Koza and Lewin (1998), networks of exploration aim at experimenting with novel combinations. New technologies are the key outcome (Gilsing & Nooteboom, 2005). Exploitation entails improvements, incremental innovations (March, 1991). Networks of exploitation aim at maximizing the joint complementary assets. The key outcomes of these kinds of networks are new products and services (Gilsing & Nooteboom, 2005). According to Nooteboom (2000), firms should be engaged in networks of exploration and networks of exploitation, but they can emphasize one of the two.
Gilsing and Nooteboom (2005) define the network between biotech firms and (public) research institutes in the biotechnology industry, as networks of exploration. The network between biotechnology firms and large pharmaceutical and chemical firms is defined as a network of exploitation.
Alliances between biotechnology firms bring the same advantages as alliances between biotech firms and universities and research institutes (Baum, Calabrese & Silverman, 2000). The network between biotechnology firms can therefore also be seen as a network of exploration. Exploration is characterized by radical innovations, therefore we offer the following proposition :

Proposition 4 : The more central a firm is positioned in a network of biotech SMEs, the more radical innovations it subsequently will have.

3. Methodology

Data

Our paper focuses on the international high-tech pharmaceutical biotechnology industry. R&D partnerships are a crucial form of inter-firm collaborations in this sector (Hagedoorn and Roijakkers, 2002; Powell, Kogut & Smith-Doerr, 1996).

In order to test our propositions, we are constructing a dataset. We used the MERIT-CATI database (Hagedoorn, 1996) to select companies that formed inter-firm R&D collaborations during the period 1990-2000 in the pharmaceutical biotechnology industry. We are linking innovation measures to the firms of these R&D alliances.

Independent variables

According to Trajtenberg (1990), patent counts weighted by citations are good indicators of the value of innovations. Therefore we will be using patent citations as a measure for innovation output.

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