Fertility and Midwifery for the International Technology Firm: The Networks and Collaborations of Red Biotechnology Firms in Sardinia'

FERTILITY AND MIDWIFERY FOR THE INTERNATIONAL TECHNOLOGY FIRM:THE NETWORKS AND COLLABORATIONS OF RED BIOTECHNOLOGY FIRMS IN SARDINIA

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Abstract

'Red biotechnology' firms are typically small, even tiny firms who have the global pharma industry as their customers, an industry that depends on them for innovation that comes from rapid scientific developments worldwide. This study is into their network and collaborative arrangements. It aims to understand what young red biotechnology firms hope to achieve with their collaborations, how they build and cultivate their networks and partners, and what helps them to make out the most out of these relationships.

A number of theoretical frameworks have been used and have been developed to understand the role of networks and inter-firm relationships among high technology businesses. The resource based view sees these relationships and the knowledge assets associated with them to be the core resources of high-tech businesses, and collaborations are both the mechanism for enhancing and gaining rent from them. The knowledge based view notes the importance of learning processes within the collaborations and within the firms to generate virtuous circles for growth and innovation. Managing this, however, can be difficult, and research has noted how close attention is required to the relationship bases of the networks and of the individuals within firms who are ultimately responsible for making it all work.

A multiple-case study is designed with a qualitative approach in order to explore these issues within six red biotechnology firms based on a science park in Sardinia. Managers closely involved in the collaborations and networking of the firms, and in the overall development of the firms, were interviewed in a semi-structured framework, based around twelve core questions. These firms differed in age and size, but were successful and growing businesses.

The study found that in this industry, networking and collaborating is not just a useful strategy approach that can be adopted, as has been presented in much previous research. Rather, it is an imperative, because both the core resources (knowledge, mainly tacit) and the main customers are accessed through collaborative relationships, within networks. But resource scarcity, particularly time, but also management experience and ability, severely limit these firms ability to make the most of their networks and collaborations, and convert them into firm growth. The authors propose that the support of scientific consultants would be of considerable benefit to these firms, who would combine their networking capabilities and social capital with those of the firms they support.

The collaborative strategy of biotech companies is based on two main legs: achieving a strategic position in the international scientific community and capitalizing on managers and scientists' networks. Red biotech firms carefully weave webs of networks and collaborations, between two essential branches of a collaboration strategy in this sector. One branch, is a strong network position in the international scientific community and with collaborative partners with good reputations. This yields reputation strength that improves bargaining position and reduces the danger of opportunism by partners. The second branch is the firm's investment in the managers and scientists' personal networks, which develop into their firm's networks and relationships. As the firm capitalize their key people's ties and networking capabilities they acquire a stronger position in the scientific community. The little biotechnology firm enlarges its web, expanding its network, and improving its network position and alliance capability.

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INTRODUCTION

Since the European biotechnology started to flourish in the early 1990s it has now grown to an €7.8bn business with 1600 firms (EuropaBio, 2005), mainly small niche firms with highly specialised expertise. 'Red biotechnology' focuses on products and developments in treatment that improve human healthcare, so firms in this sector, notwithstanding their youth and small size, are positioned globally. Not only are their markets global, being the pharmaceutical, chemical and other companies that can exploit scientific developments as products and services that can be marketed worldwide. Their principle asset, tacit scientific knowledge, is also a global resource.

We know that in knowledge-based industries such as this, collaboration strategies are very important for achieving competitive advantage and attaining growth. External networks and collaborations help complementary asset combination (Hamel, 1991), realised in the acquisition of supportive competencies, for example, funds and other resources (Mowery, 1988, Hamel *et al.*, 1989). They do much more. Through the access to and integration of intangible knowledge (Kale and Singh, 2007; Moensted, 2006; Oliver, 1997), networks present the potential of learning potential displayed through collaborations (Dyer and Singh, 1998; Inpken, 1998; Powell *et al.*, 1996), leading to innovation (Powell *et al.*, 1996).

In biotechnology, knowledge is fragmented within specialised disciplines (Powell *et al.*, 1996), so firms need to collaborate with scientific institutions or other firms to achieve goals such as the completion of a research project. Red biotech firms have to be able to find, build and exploit collaborative relationships in an effective way. This study aims to understand what young red biotechnology firms hope to achieve with their collaborations, how they build and cultivate their networks and partners, and to see what helps them to make out the most out of these relationships.

Here, we are interested in the collaborations of these firms. These include 'vertical' alliances between buyers and suppliers, 'horizontal' alliances between competitors and 'diagonal' alliances between firms in different industries. We can also see different levels of

organizational interdependence, from the highest (joint ventures and research corporations) to the lowest (one-directional technology flow, second sourcing and licensing) (Hagedoorn, 1990). Biotechnology businesses do form collaborative marketing arrangements, but are typically engaged most in research alliances, and we will focus on these. These involve technology and know-how exchanges, joint product development, and cooperative research:

> partnerships and linkages (that) occur between entrepreneurial firms, between the scientists involved with the firms, between the firms and universities, and between corporations and biotech firms (Audretsch and Feldman, 2003:277).

Cross-case comparative analysis of six cases of 'red' biotechnology firms in Sardinia, (an area rich in these firms) was undertaken to identify the importance of collaborations for these firms and to understand why and how networks and alliances are developed and cultivated. Primary data collected through semi-structured interviews was triangulated with archival and secondary data.

The paper overviews what we know about the value of collaborations in these kinds of businesses, and the management that is required within them. It then outlined the particular method undertaken here to explore it, before presenting and discussing findings concerning the importance of collaborations for these firms, the value that they provide, the origins of the collaborations and the challenges of managing them.

COLLABORATING FOR COMPETITIVE ADVANTAGE

Transaction cost theory, the resource-based view of the firm and the knowledge-based view of the firm have all offered frameworks for analysing the rationale, the governance systems and the benefits of inter-organizational networks and collaborations. Indeed, these conceptual frameworks combine to yield a powerful understanding of the theoretical potential for collaborative advantage (Conner and Prahalad, 1996; Silverman, 1999). Transaction cost theory's focus has been extended from the polar forms of organization - markets and hierarchies - to the hybrid forms of inter-firm co-operation (Williamson, 1991) which has analysed the governance forms of strategic alliances and their relatedness to the partner's motives for collaborating and to the nature of assets involved (Kogut, 1988). Efficiency seeking firms commit themselves in collaborative relationships either to achieve market entry or cost-minimization, or to develop learning systems (Kogut, 1988; Williamson, 1991).

According to the resource-based view (RBV), a firm can only gain competitive advantage by taking advantage of and capitalizing on its internal resources skills and capabilities (Grant, 1991). These need to be valuable, rare and difficult or impossible to replicate (Barney, 1991),

or else they need to combine tangible and intangible resources in such a way that the competitors cannot easily imitate them, rendering them unique (Dyer and Singh, 1998). Moreover, achieving and sustaining competitive advantage implies that a company integrates and coordinates its resources toward the realization of a specific task, since not all the resources of a firm are profitable (Grant, 1991). So cooperative inter-firm resource trading can heighten competitive advantage if it improves a firm's resource pool with external complementary resources (Grant, 1991). But this requires high receptivity and a strong learning intent (Hamel, 1991), in other words, good 'absorptive capacity'. But the resource based view has tended to neglect the link between the

> (dis)advantages of an individual firm' and the '(dis)advantages of the network of relationships in which the firm is embedded" (Dyer and Singh, 1998: 660).

Drawing upon the resource-based view and other streams of research, such as organizational learning, innovation and new product development, in which knowledge is considered as the most important strategic resource of the firm, a knowledge-based view of the firm has been designed which help explain differences between firms' performance (Conner and Prahalad 1996). Efficient knowledge utilization needs 'integration of knowledge' between the knowledge and product domains of the firm (Grant and Baden-Fuller, 1995). In the biotechnology industry, these domains are fragmented between firms, the industry being a big 'knowledge-product cluster' (Grant, 1996). Here, firms seek knowledge trading opportunities within their industry, and strategic alliances for knowledge transfer result. Collaborative arrangements therefore offer greater advantage to the firm in terms of efficient use of its knowledge and of knowledge access and integration (Eisenhardt and Martin, 2000; Grant and Baden-Fuller, 1995). It is through external collaborations that biotechnology firms particularly acquire new resources, peculiarly new knowledge, and integrate them into their current resource base (Powell *et al.*, 1996).

The relational view of competitive advantage also claims that a company can achieve competitive advantage not only through its unique and valuable resources but also by collaborating with other firms and combining their resources in unique ways: the source of competitive advantage may lie outside the boundaries of the firm, within the network in which it is embedded. Specifically, a company can achieve and sustain competitive advantage through inter-organizational knowledge-sharing routines, complementary resource endowment and effective governance (Dyer and Singh, 1998). Further, the formation of collaborations is a dynamic management process, and one that encompasses relational dimensions such as trust (Smith Ring and Van de Ven, 1992), which are critical in the sense

that they affect both the partnership benefits (Inkpen, 1998) and the choice of the relationship governance structure (Smith Ring and Van de Ven, 1992).

Since they represent the dimension where a knowledge transfer process is displayed, strategic alliances have been defined as a form of 'dynamic capabilities'. These are processes and strategies addressed to adjust the resource base of the firm, particularly in high-speed markets, by creating, achieving and integrating resources, namely new and existing knowledge and competencies (Eisenhardt and Martin, 2000; Grant, 1996; Pisano, 1994). These 'routines' generate the potential for competitive advantage.

THE SEARCH FOR COLLABORATIVE ADVANTAGE

Generally, alliance formation occurs when the advantages related to the cooperation exceed the cost incurred (Eisenhardt and Schoonhover, 1996). Alliances are formed when a firm at a strategic disadvantage need to acquire resources or when a firm invest on its assets to generate alliance opportunities, being

> 'cooperative relationships driven by a logic of strategic resource need and social resource opportunities' (Eisenhardt and Schoonhover, 1996:137).

Markets appear to be characterized by an unequal distribution of competencies and value-creating disciplines between firms. Therefore, firms choose to collaborate with their competitors not only to access complex skills quickly, but also to internalize those competences and thus to be able both to operate efficiently and enhance their bargaining power (Hamel, 1991). The need for acquisition and internalization of new technologies and skills has been a determinant for Asian companies to form alliances, whereas Western firms seem to collaborate in order to reduce costs and risks in market entry (Hamel *et al.*, 1989).

Collaborations enable access to assets, competencies or capabilities not possessed by the firm, particularly intangible assets and specialized expertise (Oliver, 1997). They can increase a firm's reputation as a serious and valuable partner, which discourages opportunistic behaviour in inter-firm relationships (Williamson, 1991). A strong social position and reputation helps trust, mutual interest, awareness and visibility, which all help firms to benefit from their relationships (Eisenhardt and Schoonhover, 1996, Powell *et al.*, 1996). Collaborations, it turn, improve firms' capability to spot new opportunities in collaborations, to manage partnerships, and to improve their absorptive capacity through new learning routines (Powell *et al.*, 1996).

So collaboration can be triggered by a need for cost and risk sharing (Mowery, 1988), the need to pool complementary skills (Hamel, 1991), or the speed, uncertainty and complexity of

technological development (Hagedoorn, 1990), and can ensuring higher research productivity in industries faced with rapid technological change (Powell *et al.*, 1996). Operating in the biotechnology field, as well as the presence of public funds, has itself been argued to be a primary driver R&D collaborations (Kleinknecht and Reijnen, 1992).

Where there is rapid technological change firms might be considered to be Schumpeterian innovators (Saviotti, 1998). But where knowledge is held within specialized disciplines as well, firms' innovative potential may be enhanced by collaborating with competitors (Powell *et al.*, 1996). The ability of collaborations to create learning opportunities (Inpken, 1998) is central here. R&D alliances create 'networks of learning' for acquiring know-how and technology and become the networks of relationships become the 'locus of innovation' (Powell *et al.*, 1996) despite the problem of property rights that then arises (Williamson, 1991). This helps explain the trend towards collaboration in the biotechnology sector, where rapid scientific and technological change require firms to quickly acquire and internalize new or complementary know-how and technologies (Liebeskind, 1996).

CONDITIONS THAT HELP COLLABORATIONS TO WORK

Collaborative arrangements are the framework in which an exchange of knowledge is displayed. Several studies have considered inter-firm networks and strategic alliances as critical for building and sustaining competitive advantage (Dyer and Singh, 1998; Inpken, 1998; Powell *et al*. 1996). This has been demonstrated arguing that the creation and acquisition of new knowledge provide an advantage relative to the competitors and that inter-firm co-operations indeed enhance the learning potential of a firm.

However, whereas an alliance creates a learning opportunity, it does not ensure 'effective learning' (Inpken, 1998). This depends on the 'absorptive capacity' of the firm, its capability to learn and to create new knowledge (Cohen and Levinthal, 1990). Within a co-operation, a firm can benefit by developing the capability to recognize and assimilate valuable knowledge from a particular alliance partner (Dyer and Singh, 1998; Powell *et al.*, 1996): a 'partner-specific absorptive capacity' (Dyer and Singh, 1998) which grows the better a firm knows its partner. So firms should consider and verify the value and accessibility of the knowledge (Inpken, 1998); if good personal relationships are deployed (Kanter, 1994) and if they are based on trust (Powell *et al.*, 1996); and if there is alignment with the partner's managerial culture (Inpken, 1998). Further, the learning capacity of the firm is heavily influenced by its existing knowledge base (Powell *et al.*, 1996).

For knowledge transfer, the strength of the firm's knowledge pool is important but not sufficient for partner-specific capacity to yield knowledge-based competitive advantage. Firms also need to tailor specific inter-firm routines in order to promote knowledge transfer (Dyer and Singh, 1998; Powell *et al.*, 1996). Also, the learning intent and efforts of the company, which seem to be stronger in Asian firms (Hamel *et al.*, 1989; Kanter, 1994; Mowery *et al.,* 1996), are a determinant for a profitable collaboration (Hamel *et al.*, 1989; Inpken, 1998; Kanter, 1994), as well as the openness of the partner to knowledge transfer and its absorptiveness (Hamel, 1991).

Kanter (1994: 96) argues that 'in the global economy, a well-developed ability to create and sustain fruitful collaborations gives companies a significant competitive leg up'. But in a knowledge-based industry, access to complementary competencies and specialised knowledge is critical. Biotechnology firms very functioning requires the acquisition and internalization of new and complementary knowledge that is fragmented and resides within different disciplines and within different firms. Through inter-organizational learning, small-young biotech firms can increase their knowledge pool and undertake viable projects. Only in this way can they become stronger competitors (Hamel, 1991).

The potential of collaborations to create and sustain competitive advantage is also enhanced by complementarily between partner firms' resources (Shan and Hamilton, 1991), especially when 'a great proportion of synergy-sensitive resources owned by alliance partners, combined, increases the degree to which resources are valuable, rare, and difficult to imitate' (Dyer and Singh, 1998: 667). Here, physical proximity between collaborating firms helps inter-firm knowledge-transfer (Dyer, 1996; Mowery *et al.,* 1996). More important is having a central position within an inter-firm network, because this improves the firm's visibility and reputation (Powell *et al.*, 1996).

MANAGING COLLABORATION

Managing collaboration, however, is a complex task that requires high level managerial skills. Therefore, how alliances are designed and managed is a crucial factor for firms that base their strategy on external collaborations; the success of those collaborative relationships depends on an effective relational governance system (Ferguson *et al.*, 2005), so effective governance can generate rents (Dyer and Singh, 1998; Keil *et al.*, 2008). Such governance is more of a big than small company concern, and is the regulatory aspect of an overall managerial process that is of more interest here. Many large high technology companies (like Microsoft or

Hewlett Packard) appoint specialist directors of strategic alliances (Dyer and Singh, 1998), but young embryonic firms cannot this, nor a business development team with whom to entrust the management of collaborations. Instead, they rely completely on their manager-owners abilities, notwithstanding the importance of external relationships and networks on the very future of these firms.

We know that networks of relationships are the locus of innovation, but these work for young firms through their collaborations, which through their numerous contacts, present the opportunity of both expanding their networks achieving central positions within them (Powell *et al*., 1996). Here, the intangible human and social, factors of the relationship are central. When a firm gains a position in a network, its relationships will be of higher trust and lower uncertainty than with transaction relationships outside such a network (Dubini and Aldrich, 1991). Further, collaborations with recognised partners provide legitimacy and reputation within the field, which are particularly difficult for small young firms to achieve in uncertain high-technological markets (Moensted, 2006). Heightened trust reduces the risk of partners' opportunism and allows smaller firms' relationships to evolve from strong personal ties to inter-firm relationships (Dubini and Aldrich, 1991).

'Cooperative routines' within networks represent learning processes that complement and strengthen internal skills and competencies (Powell *et al*., 1996). By collaborating, firms gain central position within networks, acquire experience in maintaining external ties, and 'learn' how to manage relationships (Kale and Singh, 2007). Collaborations tend to succeed, and knowledge transfer is best where managers have previous alliance experience and where the managers involved trust each other (Inpken, 1998; Powell *et al*., 1996). Here, a managements' focus on communication and fairness both enhances inter-partner trust and increases the value of the firms' networks of relationships (Ferguson *et al.*, 2005); trust seems both to trigger alliance formation and strength, and to be an effect of it.

So we see networks not only to be 'institutional' ties between firms and other organizations. They encompass a set of multidirectional contacts, informal and formal, both with the companies and between individuals (Dubini and Aldrich, 1991). CEOs social ties have a decisive influence on the company's strategy and performance (Carpenter and Westphal, 2001; Geletkanycz and Hambrick, 1997; Geletkanycz *et al.*, 2001). Managers' external ties, institutional and personal, strongly influence the decision-making process and can become important firm relationships (Carpenter and Westphal, 2001). These personal ties represent the social capital of individuals within firms, but are fundamental to the acquisition

of new knowledge for the firms (Hamel *et al*., 1989). Entrepreneurship research stresses the value of manager-owners networks in helping them to mobilize resources, to exploit opportunities through contacts, and to resource knowledge and money (Dubini and Aldrich, 1991). Relationship management skills are important for firms' ability to extract value from its collaborations (Fisken and Rutherford, 2002) and, particularly for small young biotech firms, to build knowledge-based competitive advantage from them (Keil *et al.*, 2008).

METHODOLOGY

This study aimed to explore the collaborative approaches of young biotechnology firms, and ion particular, to identify the importance of collaborations for these firms, and to understand why and how their networks and alliances are developed and cultivated, and how this presents competitive advantage. A qualitative case study approach was adopted for a number of reasons. The research sought to gain a deep understanding of the phenomenon at firm level, and at the level of the individuals involved within the firms, which required direct contact with the research setting and to go beyond the surface of the object studied (Bryman and Bell, 2003). We also wanted to delve deeper into the findings of previous quantitative research that has, for instance, measured the relationship between the number of inter-firm relationships and the network position with the alliances' fruitfulness (Powell *et al.*, 1996). But we could not, in this study gain the viewpoint of those directly involved in the management of collaborations nor examine in depth those human and social factors that are involved in the inter-personal relationships.

Qualitative case research would allow an exploration of how a collaborative strategy is developed and implemented by managers, by directly asking them about their perceptions of what they were trying to achieve and of their experiences. The case approach enables our ability to respond to "what", "why" and "how" questions (Yin, 1994), and will help us to describe the phenomenon more closely, and to generate new ideas concerning the role of collaborations in this industry, and the management factors that can help and hinder its effectiveness (Eisenhardt, 1989; Yin, 1989).

It was thought that the study of a single case, would be insufficient to address the research questions, but six SMEs operating in the field as the unit of analysis for this research, which takes the form of a comparative case study (Bryman and Bell, 2003). When the comparative design is applied in combination with qualitative research, it is defined as multiple-case study (Bryman and Bell, 2003; Yin, 1994). By using a comparative-case study approach, we were

able to achieve more consistent research and to have more convincing findings (Yin, 1994). Using between four and ten cases is considered to produce convincing findings (Eisenhardt, 1989); by then, data saturation should have been achieved, and this proved to be the case in this study. The six firms are based on the Scientific and Technological Park of Sardinia, which hosts around 20 biotech firms of different sizes and ages. This was a 'theoretical sample', based on the identification of specific characteristics that are relevant to the aim of this research (Barbour, 2008; Eisenhardt, 1989), and which is 'likely to replicate or to extend the emergent theory' (Eisenhardt, 1989:537).

Twelve companies were contacted, and were informed of the nature and purpose of the research, that that confidentiality would be protected. Two medium-sized companies are the oldest and two are very small young firms. One of the three youngest companies is a start-up. The interviewees are all managers directly involved in the strategy making process of the company, who were considered to be the most appropriate informants for this study. All but one, who has a financial background, have scientific backgrounds and experience as scientists. One of the interviewees has an MBA. Three of the interviewees had extensive management experience; two a few years' managerial experience whereas for the start-up managers, this was their first experience. Four respondents had several years' experience as researchers in the field and two had no experience as scientists.

The respondents were firstly asked to describe the company's activity and their role within it, in order to broadly identify the company's size, age and role within the biotechnology industry, as well as the interviewee's background and experience in the field. All those factors were identified for the aim of the cross-case comparison method of analysis. (All firm names have been changed to protect anonymity). All the companies are specialized in the biopharmaceutical and biomedical field, with activities from the pre-clinical work to the development and test of new drugs, including also the development of technological platforms that are employed in the biotechnology and biomedical research. Table 1 presents the firms and the respondents within the firms.

One of the primary sources of information for a case study is the interview technique (Yin, 1994) which is coherent with the method applied to this research, because it allowed clarify questions and answers, to make explicit their thought and feelings, to bring to the surface their interpretation and meanings of the topic, to yield understanding of the research object (Arskey, 1999; Blaikie, 2000; Bryman and Bell, 2003). The viewpoint, perceptions and thoughts of the interviewees were achieved with a semi-structured interview (Bryman and

Table 1: Company and interviewee's characteristics.

COMPANY	INTERVIEWEE
Founded in 1996, NeuroC began biopharmaceutical R&D in 1999. Its 35 pre-clinical pharmacological researchers explore new therapies and technologies, mainly for the central neurological system.	CEO with an Accounting/ Finance, not scientific background.
Founded in 2000, Genoma is now a medium-sized firm that was Italy's first genomics research firm. With the firm's own informatics & bioinformatics software and tools, it identifies the genetic causes of & risk factors associated with complex diseases.	CEO, a Chemical engineer.
A very small company, MacMol was founded in 2006 by a group of researchers. Its Proteomics R&D combines of diverse biomedicine disciplines to develop personalized medicines.	President, graduate of Pharma-ceutical Chemistry & Technology; specialist in Proteomics.
InVitro was born from the technology transfer of a group of Swedish research institutes. This small young Product Development company focuses on personalized *in vitro* diagnostics.	Medical Director, PhD in Neuro-psychopharmacology, with intern-ational research experience.
Founded by a group of scientists in 1997 Bioinfo's 18 scientists in Bioinformatics R&D provide bioscience research with world-class proteomics software	CEO. Genetist with business education. Scientific & business positions in the biotech industry.
Ichnos is the small start-up (2008) of a group of young and creative researchers. It provides IT solutions for biomedical and biotechnology research, particularly proteomics and to *in silico* drug discovery and toxicology.	Main board directors: one with background in Biology & Scientific Communication, B an Electronic Engineer and IT solutions expert.

Bell, 2003). All the respondents were asked the same twelve questions, sometimes in a different order, but with the use of the same structure. The interviewee sometimes expanded beyond a specific question, anticipating my questions or raising new issues. I asked further specification and questions, stimulated by the conversation. This flexible approach is particularly useful to achieve better understanding of the case and also to point out elements that could be used to develop future theories (Eisenhardt, 1989). However, too much flexibility, with the use of unstructured interviews, would not be suitable to this multi-case study; a balance has to be struck with some structure being necessary for cross-case comparability (Bryman and Bell, 2003).

All the interviews were person-to-person, two face-to-face and four via Skype. All the interviews were recorded and transcribed. Five interviews were conducted in Italian and translated, and one in English. Videoconferenced interviews allow a visual contact with the respondent, so we could benefit from the conversation like in a person-to-person interview.

Data were analyzed them according to a cross-case comparative method, selecting some dimensions and then looking for patterns of similarities and differences (Eisenhardt, 1989). The dimensions chosen for the cross-case analysis were: company's size and age, managers' experience and background. This method, applied with the help of a sampling grid, is useful to produce a rigorous analysis (Barbour, 2008), that is, to analyze data beyond the surface and thus a produce valid and reliable theory (Eisenhardt, 1989).

FINDINGS.

The research activity of all the firms relied on collaborative arrangements. Half, the youngest and smallest, base all their activity on strategic alliances, the others rating their collaborations highly within the firm's own research activity:

> They are fundamental. We are a very young and small company and, at this stage, we need to collaborate in order to acquire the competences we need to realize a research project. Unless you are a large company, you do not have all the competencies you need for that.

The R&D collaborations were almost always based on formal agreements, but four companies also had informal R&D collaborations. In one case, informal collaborations were thought to be the precursor to a formal R&D agreement:

> We mainly develop R&D collaborations, either with biotech companies and public research institutions. Many of them start as informal relationships and then need to be formalized with a contract.

Partners for these agreements are university laboratories, other biotech companies and big pharmaceutical companies. Two companies also have license agreements, while only one of the companies makes joint ventures.

<u>The value of collaborations</u>

A common factor behind all the collaborations was the acquisition and internalization of know-how and technology, and the access to complementary competencies. Collaborative arrangements gave two of the smallest companies access to new technologies that were very expensive but that were fundamental for their research activity.

> Particularly, the acquisition of expensive technologies and materials used in our research. We also acquire know-how. Our collaborations also allow us to survive, as we are a small company and we need to raise funds.

Five of the firms cited fund raising, cost saving and rationalization of resources as great advantages, and the one firm that did not mention the fund raising need noted risk sharing to be a motive for collaboration.

> Collaborations are very important for joint development of ideas and projects, in order to enhance the probability of success. They are also fundamental because they allow us to acquire and internalize external competences and know-how. We also co-operate with other biotech firms and with universities in order to better succeed with our projects. Fund raising and cost saving are also important reasons.

The oldest and biggest among the respondent firms explicitly refers to the firms' strategic alliances as the locus for ideas exchange and creation of new projects, which enhances the probability for success. The small start-up observed a virtuous circle, with opportunities for meeting new potential partners and expanding the consolidated network, and for enhancing visibility and reputation through partnership with larger companies.

For all the firms, the knowledge transfer process within collaborations added value to their know-how and their technologies. The two biggest firms used them to access to knowledge that complemented their internal competences more than to internalize and enrich their knowledge base. For the smaller firms, know-how enrichment was more important, but two of the small companies also recognised the dual direction of the technology transfer flows:

> Our collaborations indeed enrich the know-how. Some of the collaborations bring also new technologies that are very expensive in our research field. For instance, we test the proteomic products of a pharmaceutical MNE and they provide us with expensive materials we need for our research. There is a sort of exchange.

The start-up firm is learning management skills as well from its partners:

> … in this stage we are also learning managerial capabilities and skills from our partners.

Networking and collaborative strategy

All the companies appeared to recognise two main aspects in how they develop networks and collaborations: four recognizing this explicitly, and two implicitly, in their extended descriptions of what they did (without recognizing it as a 'strategy'). One aspect is developing from individual's own networks, cultivated during their careers, into firm networks and ultimately to collaborations by cultivating their managers and researchers' social networks. Another is to strategically position the firm within the international scientific environment by acquiring visibility in the biotechnology and pharmaceutical field through the participation in scientific congresses, fairs, and meetings, and through scientific publications to improve credibility, in order to expand the network and attract potential new collaborative partners.

> Our strategy is mainly based on two factors. On one hand, we go around the world, for example in scientific conferences, to present our work and results in order to develop a network of relationships in the international scientific field. On the other hand, we capitalize on our scientific consultant's personal network, which is really spread and built during years. We also try to keep the business' control and independence.
>
> We go wherever we have contacts, but I would not say we have a specific strategy. We build upon the relationships we cultivated during years, especially those of our CEO. Also, one of our researches, who is also shareholder, has a very good capacity to convince people and he goes around to talk to those he knows and trusts more. This is very useful because even when those people are not interested in your project they will address you to some other potential partner.

Interestingly, the approach does not seem to be related to firm size or age; there is an industry impetrative at play here. Notwithstanding the youth of the firm, all the managers necessarily have many years experience as managers and scientists.

For the smallest firms, partner choice seems to be influenced by mutual trust, seriousness, and partner reputation. These small companies need to benefit from the partner's strength rather than 'loose the game': they need to move in confidence and also to take advantage of

the partner's visibility and own network. Most of the firms declared competence base, meaning what the partner could offer in terms of complementary knowledge, but guarantees in terms of IP and partner's excellence in the field was also important. A company also mentions the importance of a stimulating relationship, from which innovation can arise. Another company also cites mutual interest in a common research project.

> Trust, reputation and seriousness of the partner are very important. We do not base our choice only upon our personal knowledge, but also upon other criteria such as the partner's size, its financial stability, its own relationship network and their scientific publications.
>
> We usually choose our partner by opportunity; the choice of a commercial partner is very much result driven. When we want to make R&D together, we make sure that the complementarity is very much respected. Also, the name and the seriousness of the partners is important, because being small we cannot allow ourselves to manage the relations very thoroughly, we need to move in confidence and we need strong people behind us and not people with financial crisis etc. So usually the notoriety of the partner on the market is very important for us.

For all the firms, inter-firm collaborations often arose from informal relationships between researchers, but these were then nearly all shaped by the top management, and formalized within contracts. Only the youngest firms based their alliances only on the scientists' personal networks.

> Some informal discussions and informal exchange at the level of the R&D is done between researchers, but real formal partnerships that constitute the strong background of the company are done at the level of the CEO in a very formal and professional way.
>
> We choose our partners on the basis of or personal relationships. We do not have a planned strategy at this stage. We follow a bit our instinct; many opportunities are there and we need to act quickly.

<u>The capabilities for making collaborations successful</u>

The firms require individuals who will be intermediaries between the market and the laboratory. This does not require a scientific background but a managerial attitude, and the ability to recognize valuable knowledge that needs to be acquired. Two of the interviewees noted that collaborations required managers with the capacity to identify the opportunity, to manage the relationship and to create a strong network. The relationships within the partnership are important whether or not the collaboration strategy is deliberate or 'opportunistic'. Two of the firms declared that mutual interest, a good interpersonal relationship and trust are fundamental to create synergies with potential partners and make them work in the best way possible.

> It is fundamental to find people who are willing to collaborate seriously and with whom to start a relationship based on trust. A good personal relationship between managers is also important, since collaborations are not aseptic.
>
> Interpersonal relation and trust are very important in our field. Usually we choose those companies that I personally know and some that are friends. A lot of the success of the relation is based on the trust and on the respect either between the business guys or between the scientists that really respect each other and think that really can bring a lot to each other. I think that mutual interest makes the collaboration working.

Two young firms felt that fairness was an important condition for the long-run profitability of collaborations. The start-up particularly feels its lack of managerial, financial and legal strength in comparison with its partners, so the regulation of the contract was a necessary condition to make the partnership work.

The firms that most emphasized the importance of capitalizing on the managers' and researchers' networks of relationships were satisfied with their collaboration strategy: They associated this success with the utilization of a consolidated network, and on the network capability of their 'key people', either a scientific consultant or a manager.

> The top management team jointly with our scientific consultant makes out the most from their relationship network. We are satisfied about our condition because we have our external scientific consultant who is like being part of the company and has high competencies both in public research centres and in firms; also, our president has high managerial and scientific competencies and skills.

But a shortage of time and resources to dedicate to the alliances meant that they were much less fruitful than they could have been.

> Our network of relationships with researchers helps but we lack time to dedicate to this activity.
>
> Our collaborations are fruitful but they could be more beneficial and we could have economies of scale if we had more time and resources.

Half the respondents emphasized that the biotechnology field is characterized by scarcity of time and resources, which represents an obstacle especially for small and young biotech companies in making their external collaborations as successful as possible. For this reason, the respondents indicate the need to be supported by a person or a team that plays a crucial role in fund raising, network building and strategic alliances management. While satisfied with its network size and position, the start-up saw the need for an external consultant to deal with the strategic alliances management. The companies that were satisfied with their strategy think that the collaboration strategy should be based on a strong network that comes from the investment on the key people's relational skills and network.

> I think there could be, for instance, an institution in the [science park] with the role of BD in order to help small biotech companies; a common institution could be useful to enhance their networking capability.
>
> I think time and resource are scarce in this market. We need more time to manage very thoroughly our relationships; If I had the time to manage very thoroughly the relationships, to go and visit the partners often, or have a Business Development team in order to identify the partners and make sure that we know everything about them, we could maximize the synergies and make the relationships more beneficial.
>
> … being in the [park] is a favorable condition to further raise external collaborations, since it is 'attractive' to the scientific world. They also organize one-to-one meetings. It could help to have someone to coordinate the connections, but networking is up to each company.

DISCUSSION

This exploration, despite the limited number of cases on which it is based, has pointed to some interesting issues concerning the value of collaborations among 'red biotechnology firms, how they contribute to the firms involved, what they are based on, and what the red biotechnology firms need to have and do to make them work.

Collaboration as an option or an imperative

We see very clearly in these red-biotechnology firms the competitive advantages of networks and collaborations highlighted in the resource-based view of the firm. By shaping their activity entirely around collaborative arrangements they expand and adjust their resource base (Grant, 1991) and acquire and internalize new knowledge (Eisenhardt and Martin, 2000; Grant, 1996; Pisano, 1994; Powell *et al.*, 1996). Being specialized in niche sectors, they need to combine with complementary competencies from other firms to develop unique research projects, just as Dyer and Singh (1998) indicate. But collaborations are not 'just' for competitive advantage, they are vital to the survival and growth of red biotech firms.

Pharmaceutical companies hunger for new molecules; biotech companies hunger for funds. There is an interdependence between the two macro-players supported also by complementary competencies and new technologies. Further, to exploit knowledge-trading opportunities, collaborations with Universities and between biotech companies also arise from the need to access and integrate highly specialized skills and knowledge (Grant, 1996; Eisenhardt and Martin, 2000; Grant and Baden-Fuller, 1995). All the companies studied have collaborations of these types, and the collaborative web woven lies at the heart of the firms. These R&D alliances are also crucial, as Powell *et al.* (1996) argues, because they enhance the firm's alliancing potential and centrality within their networks.

Being in the red biotechnology makes collaboration an imperative (Kleinknecht and Reijnen, 1992). The industry's logic and structure is one of many small firms with dispersed and diverse skills and disciplines that are difficult to combine in one enterprise, in a context of high costs and rapid technological change. Biotechnology firms compete to access funds and competencies through networking and strategic alliance building, and external collaborations are vital for their research activity. We see this in the large as well as the smaller firms, (though the latter are in a more dependant and vulnerable position); as Powell *et al's* (1996) quantitative study found, size is more an outcome than a trigger for collaborative arrangements, and age is not relevant.

Collaboration is for knowledge, for innovation, for a future

The benefits the firms gain from collaboration consistently confirm those noted from the resource based view, the knowledge based view, and network researchers in the area of high technology firms. Overall, they collaborate to combine complementary skills and when young, to 'learn' new competencies, including the management abilities to collaborate well.

All the case firms collaborated to combine and refresh their own resources with the partner's skills, competences and technologies, which is crucial because knowledge here is fragmented (Inkpen, 1998, Powell *et al*., 1996), unequally distributed (Hamel, 1991), and rapidly changing (Eisenhardt and Martin, 2000; Grant and Baden-Fuller, 1995). The learning value of strategic alliances seems to be greatest for the youngest biotech firms who were learning new technologies, know-how, and managerial abilities from their collaborations. The biggest firms were predominantly seeking knowledge that 'complemented' their internal competences rather than internalizing and enriching their own knowledge base.

This is an industry based on innovation, and confirming Powell at al. (1994), the networks and collaborations are not only the acquisition and internalization but also the creation of new knowledge (Eisenhardt and Martin, 2000; Grant, 1996; Pisano, 1994). There was tangible enthusiasm concerning the innovative qualities of their collaboration with their partners, but there were also important IP dangers, as Williamson (1991) noted. The only protection here was the consecutiveness and reputation role of the networks. Formal and informal collaborations enable access to intangible assets and specialized expertise (Oliver, 1997), such as reputation (Powell *et al.*, 1996), which enhances bargaining power (Hamel, 1991).

Consistently with the predictions of transaction-costs analysis, fund raising, cost saving and rationalization of resources as reasons to commit in collaborations (Kogut, 1988; Williamson, 1991). But agency is required here, and the institutions to do this in Europe differ from those in the United States. In the US, venture capitalists are active in the process of investment and networking, which is not the case in Europe. MacMol's President noted:

> In the U.S. it is quite common that a venture capitalist is interested and wants to invest in a biotech company, whereas in Italy it is almost impossible that an investor offers money to develop your projects.

Collaborations are based on networks, and networks on collaborations

Strong network positions yield visibility and reputation, and collaborations with respected partners provides legitimacy and reputation within the field, all specially beneficial for small young firms in uncertain high-technological markets (Moensted, 2006). Red biotechnology firms build their collaborative strategy upon the achievement of a strong network position and

then by capitalizing on their people's networks with good collaborations, that it turn, enhance their position within the network.

In red-biotechnology, strong network positions mainly come from visible positions in the international scientific community, and partner selection is based on 'seriousness' and 'reputation'. Nearly all choose partners for their complementary knowledge, as knowledge-based theory predicts, but often do this opportunistically, as transaction cost theory predicts (Williamson, 1991). As Conner and Prahalad (1996) and Silverman (1999) note, the transaction cost and the knowledge-based theories are not irreconcilable but complementary. Those starting opportunistically and those basing their strategy on a network approach are unrelated to firm size, and age, or manager's experience in the field. Wherever they start, the manifested strategy is effectively the same.

Collaborations develop from individual's networks, which carry immense value as has been noted widely in many types of firm (Carpenter and Westphal, 2001; Geletkanycz and Hambrick, 1997; Geletkanycz *et al.*, 2001), but these are shift into extended firm relationships. All capitalize on their people's personal networks. But this study has found that it is *the researchers'* networks, their personal ties, that are critical here, and it is these that are fundamental to the acquisition of new knowledge (Hamel *et al*., 1989). All the firms equally rely on their researchers' networks as a rich soil where to build collaborations; strategy is subsequently developed at the management level. One manager noted:

> One of our researchers, who is also shareholder, has a very good capacity to convince people and he goes around to talk to those he knows and trusts more. This is very useful because even when those people are not interested in your project they will introduce you to some other potential partner.

<u>Managing collaborations is difficult, and takes special skills that can be learned</u>

The most important factors that determine the alliance profitability are related to intangible social and human characteristics of the relationship, such as trust and relational skills. Successful management of a collaboration requires a professional approach to networking and high level relational skills. Some patterns were found in relation to firms' size and age, but managers' background and experience seem to be not influent relative to the analysis.

The literature on networking and collaborative arrangements mainly focuses on the process of learning and on what can enhance the learning capacity of partners; the learning capacity of a firm within a network or collaboration is thought to be determined by the firm's current knowledge base (Powell *et al.*, 1996). In a knowledge-based industry like biotechnology, a strong knowledge basis is assumed and taken for granted. Here, a firm's learning intent and efforts (Hamel *et al.*, 1989; Inpken, 1998; Kanter, 1994), openness of the partner to know-

ledge transfer (Hamel, 1991), and accessible and valuable knowledge (Inpken, 1991) do not discriminate between firms' collaborative and learning performance (Dyer and Singh, 1998).

But being in an industry where massive Pharma companies depending on micro Biootech companies for innovations, and visa-versa for resources, fairness in the representation of the parties' interests are fundamental to the long-term success of collaborations, as Ferguson et al. (2005) found, and this requires contractual regulation particularly when start-up firms are involved. And as Williamson (1991) notes, the problem of IP is the price paid for innovation.

There was some, but not strong support for the idea that collaborative strength is affected by the degree of affiliation between the partner's managerial culture (Inpken, 1998) and the quality of the personal relationships (Kanter, 1989), particularly as regards trust (Inpken, 1998; Powell *et al*., 1996). It seems likely that these issues are not observable in this industry because of the close relationship between the collaborations and the networks that spawn them: all those in the business belong to a community, a scientific community based on reputation and knowledge. But physical proximity between firms may enable network and alliance formation and, thus, facilitate knowledge-transfer (Dyer, 1996; Mowery *et al.,* 1996). The case firms were all based on a science park, which has increased the intangible benefits from strategic connectedness within the network, such as visibility, legitimacy and reputation (Moensted, 2006; Powell *et al.*, 1996). Two managers noted:

> This is probably one of the main reasons why we moved in the [Science Park]. We had an increment of the number of collaborations, because they naturally come to life within the Park and because the Park itself attracts potential partners from the outside.
>
> I think that being in the [Science Park] is a favorable condition to further raise external collaborations, since it is 'attractive' to the scientific world.

Networks and collaborations are vital for these firms, but collaborations are not easy to manage. High level managerial skills and building high quality interpersonal relationships are essential. Those companies most satisfied with their strategy have built their success on the networks, networking capability and relational skills of their 'key people', either a scientific consultant or a manager. One of the respondents claims:

> "Networking is a very much important resource for our company, since it allows to build relationships with people that sometimes are on the other side of the hearth. Some people, like me, are 'networking animals'; they are naturally talented for networking".

These firms, however, are typically short of time and resources, and collaborating requires both. So small and young biotech firms need the support of persons or teams for fund raising, network building and collaboration management. Relationship management capabilities are required. Small biotechnology firms could be supported by a scientific consultant and combine its networking capabilities and patrimony with the network resources of the company, a role fulfilled in the US by venture firms but not in Europe.

CONCLUSIONS

This study finds that the knowledge transfer lies at the heart of the red biotechnology business, takes place within networks between biotech companies' researchers and between firms and research institutions (Grant, 1996). We find that in this industry, networking and collaborating is not just a useful strategy approach that can be adopted, as has been presented in much previous research. Rather, it is an imperative, because both the core resources (knowledge, mainly tacit) and the main customers are accessed through collaborative relationships, within networks. We find virtuous circles, in which biotech firms' collaborative strategy involves achieving a strategic position in the international scientific community and then capitalizing on managers and scientists' networks.

We see in these firms that networks hold the opportunity to access funds and rationalize resources, as well as the innovative potential of alliances, as previous research has noted (Mowery, 1988; Powell *et al.*, 1996). We also see that being better connected in a network improves collaborative capability, as Powell et al. (1996) has previously noted. But we have identified, more clearly, how they do this. Biotech firms gain centrality in the network by capitalizing on their scientific assets and the personal skills and networks of the people they employ. Collaborations represent a high valuable source not only for high-specialized skills access and new knowledge, as noted by Hamel et al., (1989) but also for intangible assets acquisition and integration within the firm (Oliver, 1997). The youngest and smallest of these firms especially benefit from their collaborative activity with bigger and older partners. Biotech start-ups desperately need to learn how to manage their firm and their strategic collaborations. Their 'learning' within the collaborations also includes managerial capabilities that they 'absorb' from within their collaborative activity. By collaborating with firms and organizations who have good reputations, they improve their own, and gain stronger positions for themselves within their network. So they need to invest massively on their networks position and on their collaborations.

Since alliances and networks have such a high value in biotechnology, firms' activity extensively relies on this platform of inter-firm relationships. We might imagine the collaborative strategy as a spider web carefully woven between two branches. The web, the firm's network of relationships and collaborations, the branches are the foundations of the firm's collaborative strategy. One branch is building and achieving a strong network position both in the international scientific community and with collaborative partners who have good reputations. The other branch is the firm's investment in its managers' and scientists'

personal networks. Both branches grow together: the firm capitalizes on its key people's ties and networking capabilities and, through its research and networking activity, acquires a stronger position in the scientific community. The little biotechnology spider enlarges its web, grows its network, and thereby enhances its collaborative capabilities in a virtuous circle of development.

So these firms biotechnology put great emphasis on the human and relational characteristics of the partnership (Kanter, 1989); particularly, on managerial skills (Ferguson *et al.*, 2005) and on trust (Inpken, 1998; Moensted, 2006; Powell *et al.*, 1996; Smith Ring and Van de Ven, 1992). Here, we find trust to be is a key component of a profitable partnership, rather than a consequence of it.

The firms were based on a science park in Sardinia, which promote partnerships between the firms and attracts potential partners from the overall scientific community. The firms benefit from physical proximity (Dyer, 1996; Mowery *et al.*, 1996), but also being in a micro-cosmos that enhances their potential for new collaborations. But being on the park, and investing in researchers and managers' social networks, are insufficient conditions for collaboration advantage. These firms have insufficient resources, particularly of time, to develop their networking and collaborations sufficiently, or to learn how to do so. So this resource scarcity, particularly of time, but also management experience and ability, severely limits these firms ability to make the most of their networks and collaborations, and convert them into firm growth. Policy measures might consider ways of improving their networking and collaboration performance, particularly ion view of the absence of a venture capital industry in Europe to perform this function. This might involve providing the support of scientific consultants who might combine their networking capabilities and social capital with those of the firm.

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