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Dynamics of Social Capital and Their Performance Implications: Lessons from Biotechnology Start-ups

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Based on comparative longitudinal case analyses of six new biotechnology firms, this paper explores how the configuration, management, and evolution of entrepreneurial firms' social capital affect firm performance. Findings suggest that firms can realize performance benefits when their members repeatedly adapt the configuration of their social capital to changing resource needs, while inertia turns a firm's social capital into a liability. Our research provides a dynamic view of the conditions and processes that produce such inertia, allow firms to overcome it, and develop a firm's social capital to organizational advantage. A core theoretical contribution of our study is to identify and theorize how the internal organization of firms' management of relationships with external partners, through horizontal and vertical differentiation and integration, affects the dynamic of firms' social capital, adaptive capacity, and performance.●

The importance of social capital for the founding, survival, and success of entrepreneurial firms in general, and new biotechnology firms in particular, has been widely acknowledged and demonstrated empirically (Larson, 1991; Pennings, Lee, and van Witteloostuijn, 1998; Zucker, Darby, and Brewer, 1998; Oliver, 2001). Although social capital has been defined in a number of ways, the core intuition behind the notion is that it signifies an asset available to individual or collective actors that draws on these actors' positions in a social network and/or the content of these actors' social relations (Gabbay and Leenders, 1999). Social capital has potential value because it provides an opportunity for actors to access information and resources in their social network. Research on social capital has mainly concentrated on how and why firms can generate value from their social capital. It has shown in different settings that social capital provides information and learning benefits (Powell, Koput, and Smith-Doerr, 1996), increased legitimacy (Higgins and Gulati, 2003), power and control (Burt, 1992), and coordination benefits (Coleman, 1990; Uzzi, 1997). Furthermore, research has begun to demonstrate that the value of social capital depends on a number of moderators and contingencies, among these, task characteristics (Hansen, Podolny, and Pfeffer, 2001), industry characteristics (Rowley, Behrens, and Krackhardt, 2000), market uncertainty (Gulati and Higgins, 2003), prevalent norms (Gabbay and Zuckerman, 1998), and complementary capabilities (Hargadon and Sutton, 1997).

Yet research on the antecedents and consequences of social capital still faces a number of important challenges (see Adler and Kwon, 2002). In particular, to date we know very little about how organizations' social capital develops over time, about the factors and processes enabling and constraining its development, and about possible related performance implications (Baum, Calabrese, and Silverman, 2000). Such a dynamic perspective is significant because an organization faces different task and resource requirements at different stages of its organizational development (Kazanjian, 1988) and is often exposed to changing demands from an evolving internal and external task environment (Ebers, 1999). Whether or not an organization is able to accommodate these evolving demands by adjusting its social capital to

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meet new demands could have important performance implications (Hite and Hesterly, 2001). Earlier research has identified some of the constraints that actors face when trying to adapt their social capital. It was shown that particular features of social capital, for example, strong normatively grounded ties to cohesive contacts and network closure, can lead to relational and cognitive lock-in (Gargiulo and Benassi, 1999) and thus impede actors' ability to adapt to changing task environments (Uzzi, 1997). Despite the research attention, however, there is a dearth of research that outlines how organizations can overcome these constraints and adapt their social capital to changing task and resource requirements.

This paper seeks to address these challenges. On the basis of comparative longitudinal case studies of successful and less successful new biotechnology firms, this paper highlights how an organization's social capital can enable, yet also impede organizational adaptation to changing task and resource requirements over the organizational life cycle. The cases illustrate how specific features of a firm's social capital can turn from important drivers of successful firm development into core rigidities (Leonard-Barton, 1992) that contribute to inertia (Hannan and Freeman, 1984) and compromise firms' performance. A core contribution of the study is to show how the way in which firms organize the management of their relationships internally with external partners represents an important driver of and constraint on firms' ability to reconfigure their relationships and thus has implications for the performance of entrepreneurial firms, whose resource and information needs change as they grow.

THE VALUE OF SOCIAL CAPITAL FOR ENTREPRENEURIAL FIRMS

The notion of social capital has been discussed extensively in the scientific literature since the mid-1980s, when Bourdieu (1985), Coleman (1988, 1990), and Burt (1992) offered their seminal contributions to explaining the concept, and a number of different conceptualizations of it have been used in earlier research. Though no clear consensus has emerged on one definition, Adler and Kwon (2002), in their review of the concept, showed that the various conceptualizations and concerns are broadly consistent or complementary. For the purposes of the present study, we applied Nahapiet and Ghoshal's (1998) organizing framework, as it offers a reasonably comprehensive conceptualization of social capital that accommodates major concerns of the extant literature. Nahapiet and Ghoshal (1998) distinguished three dimensions of social capital: a structural, a relational, and a cognitive dimension.

Previous research on entrepreneurial firms in general, and on new biotechnology firms in particular, has demonstrated the relevance of these dimensions for explaining the value of start-ups' social capital. With regard to the structural dimension of social capital, Walker, Kogut, and Shan (1997) showed that the frequency with which biotechnology firms enter new collaborative relationships is influenced by the structure of their prior relations. Powell, Koput, and Smith-Doerr (1996) found that the number and diversity of a biotechnology firm's

networking ties, and its centrality within its network, have a positive impact on firm growth. Other research has shown that entrepreneurial firms are more likely to succeed when their network structure consists of ties that are close rather than arm's length, diverse rather than uniform, and extensive rather than limited in size (Steier and Greenwood, 2000). With regard to the relational dimension of social capital, Liebeskind et al. (1996) found that for sourcing knowledge, biotechnology firms relied on norm-based relationships between scientists. Similarly, Larson (1992) emphasized the importance of combining the initial economic control in strategic alliances with trust and norms in order to gain from the partner's resources.

The cognitive dimension of social capital, which has received much less attention, refers to similarities in actors' cognitive schemes and systems of meaning (Nahapiet and Ghoshal, 1998). Shared understandings and cognitive schemes qualify as social capital for two reasons. First, to communicate and interact effectively with persons not sharing their language and meaning systems, actors have to invest in learning and understanding. Second, this investment creates an asset that has a potential value, because a shared language and shared meanings enable actors to gain access to the information and resources of their social relations, which they could not obtain without the investment. Research has confirmed that familiarity with long-term partners furthers mutual understanding and facilitates cooperation (Gulati, 1995). Further, it has been argued that shared interpretations and orientations make it easier to exchange and generate knowledge (Boland and Tenkasi, 1995), which in turn, will have positive effects on an organization's ability to learn, adapt, and innovate (Tsai and Ghoshal, 1998; Yli-Renko, Autio, and Sapienza, 2001).

Social capital and its effects have been studied at different levels of analysis: the individual (Burt, 1997), group (Burt, Hogarth, and Michaud, 2000), organizational (Pennings and Lee, 1999), and interorganizational levels (Chung, Singh, and Lee, 2000). Our research is done at two levels. It primarily focuses on the firm level of analysis, as it aims at exploring how the configuration, management, and evolution of entrepreneurial start-ups' social capital affect the firms' performance. Following Pennings, Lee, and van Witteloostuijn (1998) and Tsai and Ghoshal (1998), however, we gauge the entrepreneurial firms' social capital as the aggregate of the social capital of individual firm members. For our research question and setting, such an approach seems warranted and possibly fruitful for a number of reasons. It seems warranted, first, because a firm's social capital builds on and is generated by the social capital of individual firm members. This is particularly true in small entrepreneurial firms. Founding entrepreneurs often use their individual social capital as an asset when starting the firm and gaining the necessary resources (Larson and Starr, 1993). During early start-up development, the firm's social capital is virtually identical to the social capital of the firm's founders (Hite and Hesterly, 2001). Second, earlier cross-level research has demonstrated that individual-level social capital can have consequences for the firm as a whole. Shane and Stuart (2002) showed how

founders' social capital influenced their firms' access to venture capital, valuation, and success. Geletkanycz and Hambrick (1997) found positive effects on performance when top managers had boundary-spanning relationships beyond their firm's core industry. Pennings, Lee, and van Witteloostuijn (1998) demonstrated that the ties of professional service firms' owners to potential clients strongly contributed to firm survival. But we still lack micro-level research that investigates how individual-level social capital is linked with firm-level social capital and firm-level outcomes (Ibarra, Kilduff, and Tsai, 2005). In this regard, our dual-level approach can be fruitful because it allows us to shed light on this understudied yet important question.

RESEARCH DESIGN

We conducted an exploratory study using a grounded-theory-building approach (Strauss and Corbin, 1998), which allows one to build on and broaden existing findings and to generate new theoretical insights in underexplored fields. Moreover, grounded theory is particularly useful for studying processes and therefore seems suitable for capturing the dynamics of social capital over time (Langley, 1999).

Sampling, Measures, and Data Collection

We conducted longitudinal case studies in six German new biotechnology firms. We selected cases opportunistically on the basis of a theoretical sampling procedure (Eisenhardt, 1989). To generate insights on how the configuration and evolution of new biotechnology firms' social capital relate to firm performance, we selected matched pairs of firms that operated under similar conditions and regulatory regimes but differed considerably with regard to performance. A team of biotechnology industry experts helped us develop relevant sampling criteria and identify three matched pairs of firms that met these criteria.

Defining performance measures for technology start-up firms is challenging. The usual accounting measures seem inappropriate because in the early stages of their development, these firms typically earn little if any revenue, invest heavily, and thus burn capital. Some prior studies have focused on survival (versus failure) as an indicator of success (Baum and Oliver, 1991; Pennings, Lee, and van Witteloostuijn, 1998), but this measure is not fine-grained enough for our purposes. Surviving new ventures differ considerably with respect to early performance: some of them grow and flourish, while others languish but continue to survive. To generate valid and more accurate measures for the success of new biotechnology firms, we decided to use the measures used by actors in the industry. Interviews with industry experts revealed that actors in the German biotechnology industry rely on widely applied proxies for the success of biotechnology start-ups that most prominently include revenue growth, employment growth, and patenting rate. We used this multidimensional performance measure as the basis for our assessment of performance.

Our sample consists of two fast-growing firms with comparatively higher patenting rates (Proteom/H and Ligand/H), and

two firms that were less successful on these counts (Genom/L and Rezeptor/L). We designate the relatively higher- and lower-performing firms with /H and /L, respectively, to make them easier to identify in our discussions. Additionally, our sample includes two firms that experienced a change in performance. One changed from growth to stagnation (Adenin↓). The other one faced performance problems at the beginning of its life cycle and turned into a high-performance company later on (Cytosin↑). The arrows after the names of these firms indicate their performance trends across the period of the case studies. Due to confidentiality agreements, we can only offer a rough outline of the underlying performance data. Successful case study firms realized an annual revenue growth of more than 100 percent, an average annual employment growth of more than 85 percent, and at the end of the study period, had full project pipelines, with more than ten patents in the application process and some patents that had already been granted. In contrast, the less successful case study firms realized only modest growth or stagnation in the three performance indicators. Accordingly, after their first four years of existence, Proteom/H and Ligand/H employed over 50 people, while Genom/L and Rezeptor/L employed fewer than ten; Adenin↓ and Cytosin↑ ranged between those two extremes.

Interviews with experts led us to control for the following context factors in our sampling that might have a moderating effect on firm performance: characteristics of the founder, the year of founding, the firm's location, and the business segment in the biotechnology industry. All the new biotechnology firms we studied were founded by scientists who had formerly worked as researchers in biotechnology at universities or research institutes. As has been typical in the emerging German biotechnology industry, none of the founders had prior business experience or formal education in business administration. Our cases should thus be interpreted in the context of an emerging industry. This stands in contrast to the U.S., where by the end of the 1990s, scientific entrepreneurs were actively accumulating business knowledge prior to founding a start-up venture or could draw on personal experience with earlier foundings, though in the emergent phases of the U.S. biotechnology industry, business education was also rare among scientific entrepreneurs (Henderson, Orsenigo, and Pisano, 1999). Because all the firms were founded in 1997 and were based in large and important biotechnology clusters, we could hold constant possible institutional and spatial contingencies that can affect firm founding and success (Baum and Oliver, 1996; Porter, 1998). The case study companies were founded after the first year of the German-wide BioRegio competition, a governmental program that provided seed capital to German biotechnology clusters in order to spur founding rates, secure financial backing for them, and help the German biotechnology industry to make up time and compete with U.S. and U.K. firms, which were believed to be ten years ahead. Because they were located in the program's winning regions—Munich Martinried and the Rhein-Neckar-Triangle—the case study firms were exposed to favorable founding conditions in terms of governmental support and industry reputation. Finally, we

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controlled for product market and technology by sampling matched pairs from three different segments of the biotechnology industry. In this way, we could take into account differences in the ease with which new biotechnology firms could raise capital, the intensity of competition, and the risks and challenges posed by research, product development, and commercialization of the product offered. Genom/L and Proteom/H operate in the drug discovery and development segment and thus face high risk and uncertainty. They are engaged in the discovery process of new drugs, an uncertain journey that can take up to ten years and requires about U.S.\$500 million. Despite an investment boom in the German biotech industry at the time of our study, new biotechnology firms in this industry sector usually found it difficult to raise money. Investors were cautious and preferred to invest in firms that developed widely applicable platform or enabling technologies. The two bioinformatics firms in our sample, Rezeptor/L and Ligand/H, develop these latter technologies and thus had potential access to a more favorable supply of funds. Bioinformatics draws on insights from biology and informatics to provide software tools that analyze and model complex biological data for drug development. The two diagnostics firms, Adenin↓ and Cytosin↑, develop and market tools for detecting microorganisms or diagnosing diseases. Compared with firms in our other two segments, ventures in the diagnostics segment are less research- and capital-intensive and face less technological risk, although the large number of competing diagnostic tools and methods leads to intense rivalry in the industry.

Data collection took place from January 2000 until March 2001. We followed Yin's (1984) call for multiple sources of evidence and collected data through interviews, site visits, and archival records. The primary sources were 19 semi-structured interviews, each lasting approximately an hour and a half. The interviewees who were our informants were the founding entrepreneurs and senior scientists who had joined the new biotechnology firm at founding and were therefore able to report on the company's development. With the exception of one case, we conducted interviews with all active founders and a majority of the senior scientists who had joined the case study firms at the time of founding. Details on the number of interviews with industry experts and within each company are presented in table 1, along with illustrative interview questions.

Data collection covered developments from each firm's founding in 1997 until 2001. The semi-structured questionnaire guiding our interviews included questions designed to gather information on the individual respondent, the company's history, organization, and performance, and the nature and importance of the company's external relationships at each step of the firm's development. The questionnaire guided and structured our loosely framed, yet problem-focused interviews. Each interview involved two researchers and was taped and transcribed to ensure reliability (Eisenhardt, 1989). We asked our informants for information on the structure and relational and cognitive content of their relations with partners outside their firms, beginning at the time of founding.

Table 1

Interviewees and Illustrative Questions	
Respondents	Illustrative questions
Sample criteria and case selection (4 team sessions)	
Experts:	"How do you decide whether a new biotechnology firm is successful, above average or ineffective?"
Venture capitalist A	"Which start-ups that you got to know would you characterize as absolutely outstanding?"
Venture capitalist B	"Please name an unsuccessful counterpart."
Banker	
Biotechnology entrepreneur	
Development of case study firms' social capital, 1997–2001 (19 interviews)	
Proteom/H: Founder A	"If you think back to the time of the founding of the company, what contacts did you or your colleagues have that were especially important for the company?"
Founder B	
Founder C	"How did these contacts change over time?"
Senior scientist	"How many (different) contacts do you have?"
Genom/L: Founder A (2 interviews)	"Do the external partners know one another?"
Founder B	"Describe the communication with the external partners (How? How often? What about?)"
Senior scientist A	"What makes this relationship work? How, or from what source, does every partner know what to do?"
Senior scientist B	
Ligand/H: Founder	"How would you describe the purpose and business logic underlying the relationship of your firm with this contact, from your point of view/from your partner's point of view?"
Senior scientist	
Rezeptor/L: Founder	
Senior scientist A	
Senior scientist B	
Adenin ↓: Founder A	
Founder B	
Senior scientist	
Cytosin ↑: Founder	
Senior scientist	
Enrichment and validation of case material (5 follow-up sessions)	
Experts:	
Venture capitalists A and B	
Banker A (3 sessions)	"Please relate the anonymous case write-ups to a company name from our sample."
Biotechnology entrepreneur	

On the structural dimension of social capital, for instance, we asked with whom the interviewee had external ties and how frequent and intense their interactions were with that person. On the relational dimension, for example, we determined whether and how these relationships relied on common norms, trust, or contractual agreements. Questions on the cognitive dimension of social capital asked interviewees about such things as their goals and interests for specific external relationships, important drivers affecting the relationship, and whether and how these views aligned with those held by their external relations. Following our exploratory research logic, however, we remained sensitive throughout data collection to the way our informants defined important and valuable aspects of their relationships. We asked our informants which information and resources they tried to access through their external ties and whether and why they succeeded or not. We also asked which information and resources the firm needed at different times in its development. During a subsequent step of data collection and valida-

tion, the team of industry experts who had helped to identify more and less successful firms provided feedback on the data and their interpretation. We gave the experts brief summaries of the cases. They provided further detail on the case material, clarified open questions, and validated the case accounts in five follow-up sessions that lasted from two to four hours.

Data Analysis

Data analysis followed procedures recommended by Miles and Huberman (1994) and Strauss and Corbin (1998). From our interview and archival data, we first compiled individual case studies for each firm, in particular, the process pattern of time-ordered events and the corresponding external relationships. Then we expanded the individual case descriptions by adding the effects of specific configurations of relationships as outlined by our informants and found in written documents. This resulted in thick descriptions of each firm's resource needs, external relations, and firm performance at each point in the firm's development. The completed case write-ups were checked by industry experts. Using the validated case accounts, we then compared matched cases and noted similarities and differences within each pair, gradually expanding cross-case analysis. We used new permutations with each iteration of case pairs and thereby compared cases across different variables. In the course of this iterative process of data analysis, we identified specific patterns across the cases in how the new biotechnology firms had composed, managed, developed, and more or less successfully exploited their social capital.

We took care to address a number of the challenges in analyzing social capital that Portes (1998) identified. First, to avoid tautological reasoning, we clearly separated our notion of social capital from its effects theoretically and empirically. Following extant literature, we conceptualized social capital as an asset rooted in the structure and relational and cognitive content of actors' ties with other actors; the positive and negative outcomes in terms of the performance measures we used are clearly distinct from this conceptualization. Second, through careful case selection, we controlled for the possible influence of independent variables that might account for both social capital and firm performance, including factors associated with important personal characteristics of the firms' founders, regional institutional embeddedness, task, and technology, as well as circumstances at the time of founding. We observed similar patterns across regions of origin and the business segments of the studied firms. Factors in the institutional context that vary by region and by task, technology, and business segment thus do not seem to have played a major role in the development of firms' social capital. Third, we established the directionality of relations among variables that we present in our account on the basis of detailed empirical timelines documenting our variables at each point in the firms' development. This allowed us to determine that the noted organizational mechanisms did in fact trigger changes in the configuration of individual-level and firm-level social capital, which then entailed the performance effects we report.

FINDINGS

Configuration of Firms' Social Capital over Time and Performance Implications

We identified two distinct phases of firm development, an early start-up phase and a subsequent business development phase. The early start-up phase extended from the first formulation of a business plan for the new venture through the legal creation of the firm and ended when the funds from the initial financing were nearly exhausted. The subsequent business development phase extended from the first activities aimed at securing further financing through the second financing phase and until the end of our study period. The configuration of social capital for the more successful and the less successful firms in these two phases showed markedly different patterns.

Table 2 presents illustrative quotes from our cases that characterize the new biotechnology firms' social capital in its structural, relational, and cognitive dimensions for the early start-up and subsequent business development phases. For brevity, we report similarities and differences among our four extreme cases of high-performing (Proteom/H, Ligand/H) and low-performing companies (Genom/L, Rezeptor/L). Further evidence from all six cases is presented in the text below.

Early start-up phase. When the six new biotechnology firms were founded in 1997, the structure of their external ties was broadly similar. They were all embedded in networks consisting almost exclusively of other scientists. Founders and senior scientists in the companies had acquired experience at various research institutes and had established excellent contacts in the scientific community. Some of the firms, for example, Genom/L and Cytosin↑, could look back on as much as ten years of experience as standing workgroups in biotechnology research. This history had resulted in a scientific network of manageable size and of partners who met on a regular and informal basis at a research institute or at scientific conferences. One scientist described the situation at Cytosin↑: "That [network] was a small clique of people, all scientists. We met constantly and knew the others. If you looked outside the network once, of course, nobody knew you, but we didn't know that back then."

On the relational dimension, entrepreneurs and senior scientists confined their exchange relationships to fellow scientists who had turned out to be trustworthy and competent in the past. Others were excluded from scientific exchanges, as Genom/L's founder explained: "You also know the people who you will have to call ten times to finally get the material three months later. These are still nice, but they are chaotic. You can't rely on those contacts. It costs you too much time." The scientific contacts provided rapid and unconventional mutual support and assistance. Typical support consisted of the exchange of material or cell lines, access to an electron microscope or other kinds of research equipment, and the services of weighing and taking measures of molecules. As one senior scientist commented, "We send material to another workgroup. That is not even real cooperation. That is material that we are able to make very easily, and you

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simply send it over and vice versa. If we need an anaphylactic, they send it to us. We don't write a bill or pay any money for it." In the course of time, the ongoing exchange of goods and services established expectations of reciprocity and fostered the scientific norm of give and take. As a founder of Genom/L said, "Of course, we do them [other scientific workgroup] a favor once in a while—even if that doesn't please us. But that is how everything works. Eventually, we will need their help again." Our informants noted many positive implications of the reciprocal relations that governed their scientific exchanges. In their view, reciprocal relations were "the reason why the [scientific] network works that well" (Proteom/H), "an element of the work within the project" (Cytosin↑), and "the foundation for our scientific work" (Rezeptor/L).

Table 2

Evidence from Data Illustrating New Biotechnology Firms' Social Capital

Proteom/H	Ligand/H	Genom/L	Rezeptor/L
Early Start-up Phase			
Structural dimension: Small network confined to fellow scientists			
"We are the typical university spin-off where business amateurs lead the way. The network started relatively small. We had a scientific workgroup and only academic contacts."	"We [the founders] brought a scientific network into the company. This included contacts with the institute, with other colleagues, and also with other bioinformatics scientists. This goes back to the networking actions of each key person who was part of the founding of the company."	"We had a reasonable amount of academic contacts. Just because we have been working in the field for over ten years now, new contacts are made and old ones are lost. The ones that are really important stay."	"After being in science for over 20 years, we simply had certain contacts. That [network] was a small group of colleagues."
Relational dimension: Strong scientific norms and mutual trust			
"In the scientific community, you give things away to get things back later. That's why you must also supply to the community."	"It was always clear which colleagues were best to work with and on whom you could rely. You would willingly perform favors for these trusted colleagues because you know something will come back from this person."	"You always know for certain who is reliable and who gets you the material within one week. Thus, you can make a time schedule that is being followed."	"Science is a system of giving and taking, not only taking."
Cognitive dimension: Homogeneous set of scientific goals and orientations			
"At that time, I did not think about what would happen if I was not able to file a patent. A patent was a by-product, a waste product, of the scientific activity, the publication, so to say."	"The universities always made us believe that patents were associated with greed for money. This perception is typical for German scientists. That is why, as a scientist, you prefer looking at the publication even when that means that a clinical application might not be practicable because of a lack of trademark rights."	"For a scientist it is important that he has a continuous list of publications. There can be no two-year gap simply because of a patent that he does not want to publicize yet."	"The main goal, of course, is to make presentations at scientific conferences and to have publications. The rest is not really important."

(continued on next page)

Table 2 (Continued)

Proteom/H	Ligand/H	Genom/L	Rezeptor/L
Business Development Phase			
Structural dimension:			
Access to distinct external networks		Focus on scientific network	
"You look for suitable cooperation partners that help you in scientific fields. On a political level, you search for someone who helps you with your image. Then we have a large network for business administration, including the tax office, auditors, lawyers, PR agencies and others. Banks and VCs are another important factor. For each named target group, there are certain networking activities that we arrange."	"We have cooperation upfront for the founding research with partners and scientists. And on the other side, the customer side, with Big Pharma. Then there is the contact with the lawyers and auditors, and of course the investors for the IPO."	"Compared to former times we now have one additional partner. That is our industry partner. Through him we are also financed." "This may sound crazy, but we don't need any additional contacts."	"We are very active in science. We will continue to be so." "I would not say that our network now is different compared to our time as scientists. Actually, it's the same."
Relational dimension:			
Relationships outside scientific community layered with trust		Relationships outside scientific community rely on contractual agreements	
"The commitment [of lead investors] was extremely high. The enthusiasm was also 120%. We could rely on the fact that everything would be arranged for us. . . . We knew for certain that they cared for us and that it was important for them to know what happens to us in the future."	"That cooperation [with Big Pharma] deals with large sums of money and, of course, everything is managed by contracts. It is then important for the success of the following deal to build trust at the first project. Trust in our ability to do it and confidence that we will still be there in 3 years."	"So far, our partner has kept what we agreed upon in the contract. And when we have conflicts we simply have a shareholder meeting. That is the arrangement. That is the normal procedure."	"Those [new ties] are normal relationships with customers: service for money."
Cognitive dimension:			
Integration of business orientation		Focus on scientific orientation	
"We do not publish until we are certain that our patent is secure and our results are uninteresting for our competitors because the patent covers everything."	"The generation of knowledge itself became a tradable commercial commodity for us." "The conflict between the publication and the patent should not really exist. If you organize it the right way, it is not a problem."	"We approach that topic from the scientific side. He [co-founder] has more extreme scientific expectations than I. This translates into even less thought about what is important for the investor."	"We mainly present our concept in a scientific competition." "We are scientists. The main important thing for us is credibility. That is only possible at scientific congresses and with publications."

On the cognitive dimension of relations, the common socialization in a research environment and the ongoing exchanges had strengthened a homogeneous set of scientific goals and beliefs that guided collaboration among network partners. Firm founders described themselves at the time of their

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firm's founding as "business amateurs" (Proteom/H) who "went off playing entrepreneur" (Cytosin↑). They approached their work mainly from a scientific point of view, focusing on the amount and quality of scholarly publications that their research would generate. As one informant told us, "The scientific network partners are all oriented in the same way" (Rezeptor/L). "If you consistently meet people over such a long time, you know each other. You have a beer with them once in a while. These contacts are not only scientific, they are almost on a personal level" (Genom/L). Based on their shared identity as scientists, the scientific network partners formed what one informant referred to as a "well-functioning neighborhood in which you help one another out" (Rezeptor/L). Because they shared goals and interests, researchers could quickly and effectively access resources from other scientists: "When we need material, I simply use my contacts. For them it's not a big effort. For me it would be an extremely big effort. On this scientific base it works well" (Proteom/H). The shared identities and similar cognitive schemes within the scientific network also eased access to public seed funds from initiatives of the German Federal Ministry of Research because those reviewing the proposals shared the new biotechnology firms' professional backgrounds and evaluated their first proposals according to scientific relevance and scientific merit.

Taken together, these features created a configuration of social capital in these firms that was characterized by shared professional identities among partners, cohesion, and closure (Coleman, 1988, 1990). These characteristics facilitated the founding and early start-up processes of the new biotechnology firms. The scientific networks of all the firms provided reliable and timely access to the equipment and material needed. They were vital for developing the product proposals on which the entrepreneurs built their companies. As one of Rezeptor/L's founders stated, "The scientific network enabled my research group to come up with all these scientific developments that were crucial for the founding of the firm. . . . This network is of utmost importance. One can achieve things that would be impossible without it."

Business development phase. The informal relationships of mutual support among individual scientists characterized all the case study firms over the course of the first four years of their existence. Yet otherwise, successful and less successful firms took very different routes in their later development phases, specifically with respect to how they developed and managed their social capital. The less successful firms continued to value and concentrate on their relations within the scientific community. As indicated in table 2, the social capital of the less successful firms thus remained fundamentally unchanged at the end of our study period. In contrast, the more successful firms maintained relationships in the scientific community but, at the same time, managed to reconfigure their social capital fundamentally on all three dimensions. On the structural dimension, one informant at Proteom/H described the situation after the early-founding phase as follows: "The network is growing more and more quickly." As corroboration, this informant pointed out that the number of

Christmas cards written and received had almost tripled from 75 cards in 1999 to 200 cards in 2000. Ligand/H had formed four technology transfer agreements with research institutes and four research collaborations with industry partners by the end of 2000. Over time, Proteom/H, Ligand/H, and Cytosin↑ extended their networks beyond the closed scientific networks and transformed them into a set of differentiated relationships. The newly formed relationships comprised a range of distinct and disconnected external partners: scientific contacts with scientists and research institutes, administrative relationships with lawyers and tax consultants, political contacts with local authorities, ties with the finance industry, and relations with customers. These relationships are reflected in the quotes in table 2. An informant at Proteom/H described the change in the firm's network structure in this way: "We severed many of our former [scientific] contacts, although we had been working very closely for many years. But, on the other hand, we accessed a lot of novel partners from different fields of the industry."

On the relational dimension, the less successful firms focused on their established scientific contacts. They described newly created non-scientific ties as being superficial, based on mere contractual agreements and formal procedures. The more successful firms, however, intensified and strengthened some of their newly formed relationships. They developed multiplex relationships and supported them through a number of different bonds. A founder commented,

We [Proteom/H and a Heidelberg research group] started with studies. From that we came into close contact. From that we found out that we also have something in common on a personal level. . . . Heidelberg University now houses our biological test system. We have regular meetings and exchange many telephone calls.

Similarly, informants in successful firms described some of their relationships outside a scientific network, especially to first customers and lead investors, as close and inlaid with mutual trust: "The relationship [between Cytosin↑ and an investor] gets closer all the time. The relationship is not just a source of financing; it also is a source of advice. It is a real partnership where one can trust each other."

On a cognitive level, intense contacts outside their scientific community provided stimuli that challenged the individual actors' homogeneous set of scientific goals and orientations. A scientist at Ligand/H reported, for example,

The preparation [for the financing round] was exciting. The teamwork with the investors was intensive and interesting. It took some time until we became accustomed to one another's thinking. In the beginning, there was just a group of scientists and technologists that had no idea where the money grows.

Founders and scientists still viewed their firms as science-oriented companies, but they learned to couple their research orientation with concerns about economic performance and proper business conduct. As an informant at Ligand/H said, "We are simply market-oriented unlike other biotechs that want to research in secret. Of course, we also aim to eventually have a product. That's why we research. But we want to

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gain revenues fast, even if they are small.” Investments in learning processes broadened actors’ cognitive schemes and allowed firms to gain access to new external partners, which again provided new learning opportunities. Proteom/H, for example, decided to exploit contacts among its administrative and political relations to learn about the necessity of approaching representatives from the finance industry and successful ways of doing that. Proteom/H could thus float a first version of its business plan and use the feedback from its established relations to improve it, without risking its reputation with venture capitalists. When Proteom/H finally approached venture capitalists with the polished version of its business plan, the venture capitalists did not know that there had been earlier, less professional versions. Similarly, Cytosin↑ used coaching ties outside the venture capital arena to prepare for financing rounds. Such investments in their cognitive social capital allowed actors to understand better their new partners’ business orientation and align themselves with it. As a result, actors could more easily obtain valuable information, and it became more likely that the advice received would have consequences for managerial action. A founder of Proteom/H described this kind of relationship: “We [Proteom/H and the leading investor] understand each other, are on the same wavelength. They pass on interesting news and information immediately. We receive good advice. And, of course, we accept their advice.”

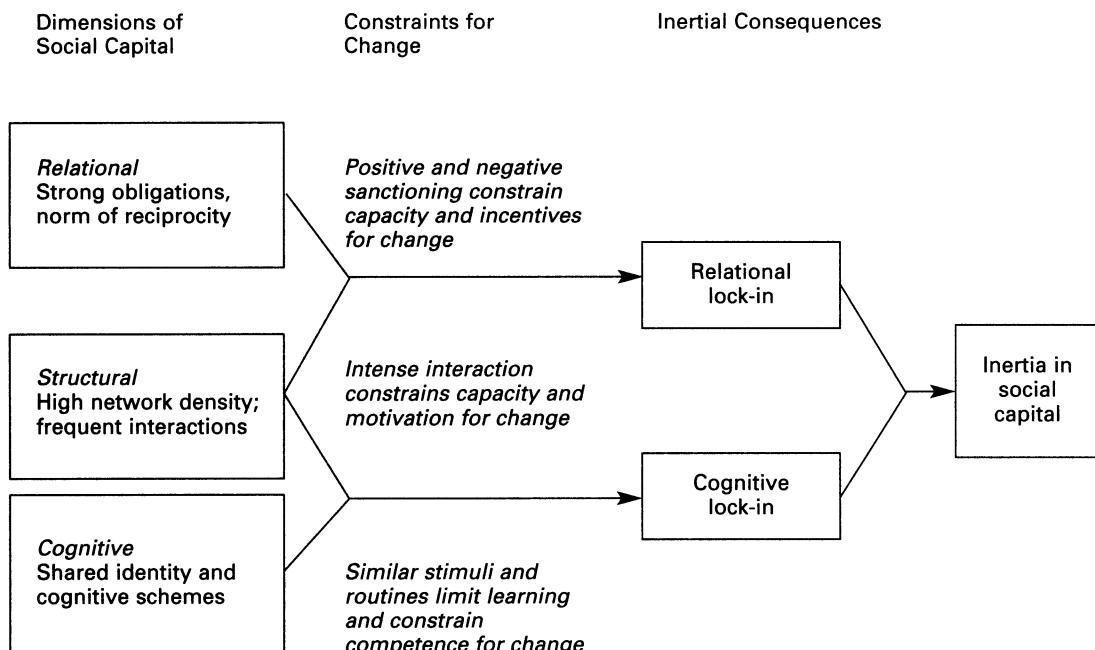
In aggregate, this resulted in a configuration of social capital that was characterized by network differentiation. Network differentiation allowed new biotechnology firms to identify and effectively access novel information and the resources needed for their sustained development and improved performance during the subsequent business development phase. Yet while some of the studied firms, after the early start-up phase, managed to open up their closed and cohesive networks, sever established strong ties, change their members’ cognitive schemes, establish new relations with a more diverse set of contacts, and reap the resulting benefits, others could not, largely because of the inertial forces of their social capital.

Social Capital’s Inertial Forces

We identified two inertial forces—relational lock-in and cognitive lock-in—that impeded the less successful firms’ ability to adapt the configuration of their external relationships according to changing information and resource requirements in the course of the firm’s development. The inertial forces are rooted in the configuration of the new biotechnology firms’ early start-up social capital. Together, they contributed to inertia in social capital because they constrained organization members’ capacity, incentives, and competence to sever old ties and to forge ties with new external partners. Figure 1 summarizes the gist of our findings in terms of the three dimensions of social capital.

Relational lock-in. Our data show that relational obligations and norms of reciprocity, together with high structural density in actors’ external relations, generated relational lock-in. These relational and structural characteristics of their social

Figure 1. Conditions contributing to inertia in social capital (lock-in) in start-up phase.



capital constrained actors' capacity and motivation to change the composition of their external ties and thus contributed to inertia in social capital. The prevailing norms of reciprocity, on the one hand, created positive incentives for firm members to continue to invest considerable time and energy in nurturing their established scientific ties. One informant at Rezeptor/L explained,

You cannot simply break with contacts [in the scientific network] that easily. If somebody who was always important for us contacts me, I try not to let him wait too long and react as soon as possible. That costs time. And as we have several contacts within the community, it costs a lot of time—but you will only get when you are willing to give.

On the other hand, our informants were aware of the negative consequences that might follow if they did not meet their obligations toward their fellow scientists. A Genom/L founder was aware of this during his search for providers of venture capital:

That time was not nice. I was often away and so many other things were going on in my head. At that time, I had the feeling that, if I continued searching for venture capital, I would neglect my scientific contacts and the workgroup at the institute. That means the [research] project suffers if I search for venture capital any longer.

Shortly afterwards, Genom/L broke off the search for venture capitalists.

The structure of their external relations further constrained our informants' capacity and motivation to forge new ties. Entrepreneurs at Genom/L, Rezeptor/L, and Cytosin↑ reported that due to the intense communication and interaction in their existing scientific networks, they simply lacked the time

and energy to establish new relations. Moreover, network density amplified the negative incentive effects associated with a break-up of established reciprocal relations. Given the dense communication channels within the scientific network, partners would soon be informed about a violation of norms of reciprocity and could exclude the non-conforming firm from resources that had been, and continued to be, important drivers of scientific success and reputation. As an entrepreneur at Rezeptor/L maintained, "You cannot afford not to react upon requests. Something like that gets around very quickly, and then in the future you cannot expect any help anymore."

Cognitive lock-in. Our case evidence suggests that particular cognitive characteristics of actors' social capital (a high degree of similarity in actors' identities and cognitive schemes) in conjunction with specific structural characteristics (intense and frequent relations with a limited range of partners) constrain actors' motivation, capacity, and competence to change the composition of their external ties and thus contribute to inertia in social capital. Our informants identified themselves primarily as scientists, as did the fellow scientists with whom they most often interacted. These shared identities and cognitive schemes centered on scientific goals and standards, and the established scientific frames of reference were so dominant that new biotechnology firms' entrepreneurs also applied them when confronting new business challenges and non-scientific partners. For example, first versions of firms' business plans resembled research proposals, with heavy emphasis on the scientific outcomes of the projects. As a senior scientist at Genom/L stated, "At the end of the day, there has to be a publication. You search for a protein and its function. Then, you publish your findings. I simply never visualized what might happen with that protein in the production." At Rezeptor/L, researchers harbored the assumption that venture capital was distributed on the basis of scientific innovativeness: "If you want to convince investors, the only way is with scientific credibility through publications in top journals." Four years after founding their firms, the core members of Rezeptor/L and Genom/L still regarded informal scientific contacts as their most important contacts and viewed venture capital as well as public start-up grants as means for realizing scientific freedom and future research progress. They were thus strongly motivated to nurture scientific relationships and to regard contacts outside the scientific community as less important. The resulting intense and successful interaction with like-minded fellow scientists reinforced the entrepreneurs' prevalent identities as scientists and the related cognitive schemes.

Because the ties with fellow scientists who shared their cognitive schemes were intense, our informants had little opportunity to experience divergent views. As a result, they lacked the capacity and competence to relate effectively to partners outside the scientific community. When such contacts did take place, our informants described their related experiences as "painful" (Cytosin↑), "demanding" (Ligand/H), and "embarrassing" (Adenin↓). A founder at Cytosin↑ described the situation: "We had to totally change our way of thinking.

That was not easy and also painful. At the beginning, we were not able to answer the question of how we want to gain revenues." Another founder commented, "Our world and their world were too far away from each other. In our business plan, there was still too much emphasis on science and too little on the market. We just didn't have in mind what was important for VCs [venture capitalists]."

As they experienced difficulties in relating to business partners who applied different frames of reference, some founders clung to their familiar ways, retained their identities as scientists, and continued to focus on their scientific goals and contacts. A founder at Rezeptor/L described his experience:

I talk to the people and try to find the right language. This is quite easy when talking to scientists. For non-scientific partners I try to find the right passwords. . . . In the long run, this is quite demanding. That's why I concentrate on my job as chief scientific officer. This comes closest to what I've learned in the past.

Genom/L's founder explained, "This is endless stress that is not to anyone's advantage. That's why I'll focus back on the scientific side of our business and the research project."

While the entrepreneurs would not accept more business-oriented frames of reference, they could not fully ignore the demands of their non-scientific partners either. Over time, they learned to accommodate the frames of reference of their business partners, albeit it in a superficial way that allowed the entrepreneurs to continue to follow their scientific orientation. For example, later versions of Genom/L's business plan were revised to include catchwords valued by potential financiers, such as expected revenues or market share. Moreover, Genom/L's entrepreneurs developed a four-year project plan as a guide for business development that covered the walls of the firm's conference room. But this plan was structured by scientific conferences and publication milestones.

Overcoming Social Capital's Inertial Forces

We identified three organizational mechanisms that enabled the more successful firms to overcome the inertial forces inherent in the initial start-up configuration of their social capital: horizontal differentiation (specialization), vertical differentiation (delegation), and organizational integration of relationship management. Table 3 presents illustrative case evidence that characterizes how the more and the less successful firms differed in how they organized internally the management of their external relations. Using these mechanisms to manage their relationships enabled firms to adjust their external relations, and thus to meet novel resource and information needs, by enhancing organization members' capacity, incentives, and learning opportunities, as illustrated in figure 2.

Horizontal differentiation: Specialization of relationship management. When founding their new biotechnology firms, entrepreneurs faced a profusion of novel business, managerial, and legal challenges. As fully devoted scientists,

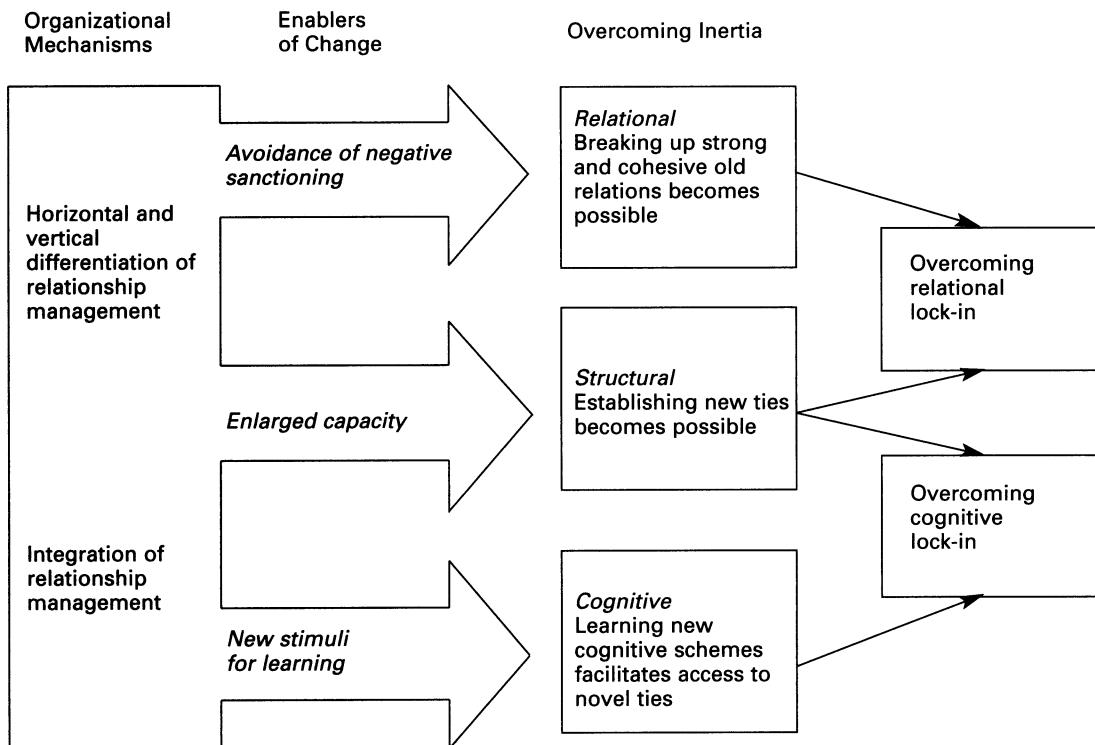
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Table 3

Mechanisms for Overcoming Social Capital's Inertial Forces			
Proteom/H	Ligand/H	Genom/L	Rezeptor/L
Organizational differentiation: Specialization of relationship management			
High		Low	
"The task specialization in the management team is really important to us. [Founder A] is responsible for R&D, [Founder B] for business development and I [Founder C] cover the financial side, the controlling and stuff. To us, it's important to clearly define and separate our competencies. Thus, you always know who is responsible and who will cultivate the necessary relationships with our partners."	"Of course, in some way, he [CEO] is our leading man. Yet, each member of the management team [CEO, CSO, CFO] has to fulfill specific tasks and to manage the corresponding [network] contacts. That's part of our network management."	"I [founder] manage all the investor relationships. I also cultivate the contacts in the scientific field."	"I [founder] am wearing various hats at the moment. . . . I establish and manage most of our external relationships."
Vertical differentiation: Delegation of relationship management			
High		Low	
"I [founder] don't really cultivate personal relationships in the scientific community. It's our senior scientists who do that."	"We [employees] cultivate contacts in the scientific field. I know about five or ten people at the institute. I can call them when I need scientific advice."	"I [founder] still go to scientific conferences. I also maintain my personal contacts in the [scientific] community. They are important."	"I [founder] still try to attend scientific conferences. . . . I don't want to lose contact with real science."
Organizational integration of relationship management			
Intense/Diversified		Intense/Cohesive	
"The firm is really big now. We use cross-functional teams to exchange information."	"We [management team] talk to each other quite regularly. We share information. We report experiences each has made in his network."	"It's not different from our time as a research group. We meet regularly, once a week. We discuss our research project and the next steps to be taken."	"We have regular team meetings where we present and discuss scientific findings."

they were inexperienced in dealing with many of the new tasks that awaited them. In response to these challenges, successful firms introduced a specialization within the founding team after the early start-up phase. A founder at Proteom/H made this clear: "This specialization emerged quite early. Even our standard company presentation follows three different topics: general introduction to business strategy, science, and financial planning." In line with this task specialization, each member of the management team was responsible for cultivating distinct partnerships within the firm's overall set of relations. At Proteom/H, for example, one of the founders was responsible for science and technology, securing Proteom/H's intellectual property, and coordinating existing research collaborations. Another management team member was responsible for all financial aspects of Pro-

Figure 2. Overcoming the inertia of social capital in the business development phase.



team/H's venture capital investment strategy, the completion of two financing rounds, and planning for further financing rounds; he managed relationships with venture capitalists as well as with lawyers and tax consultants. A third member of the management team was responsible for acquiring further research collaborations and integrating Proteom/H into the international biotechnology network.

Specialization of relationship management enabled firms to overcome their social capital's inertial forces for several reasons. First, it allowed them to avoid overload. Overload arises when too many or too different relationships have to be cultivated by a limited number of people. By putting external relations on more shoulders, firms increased their capacity to extend the volume of their external relations. Second, specialization helped entrepreneurs to sever former bonds and obligations in their scientific network. Because their formal responsibility had changed, entrepreneurs felt they had both the right and the duty to concentrate on novel relationships. At the same time, entrepreneurs could feel assured that one of their fellow founders would still serve as a link to the scientific community. This alleviated anxieties about possible sanctioning of the firm.

Our [Proteom/H's] CSO [chief scientific officer] now is in charge for the working sessions with our scientific partners and their coordination. I'm not involved in any research activities anymore. [Our CSO] is, so to speak, our spokesman for the scientific community. As you can read from my business card, I'm in charge of and feel responsible for finance and accounting. During financing rounds, I stay in contact with authorities, tax advisers, auditors, and investors.

And the chief scientific officer confirmed that, for him, the number of scientific conferences had not decreased since the firm's founding. Third, specialization within the top management team for particular external contacts gave actors sufficient time and capacity to learn about and from their respective partners. This can contribute to reducing cognitive inertia. As the chief financial officer (CFO) of Proteom/H described it:

How do we manage to be in contact with so many diverse partners? By learning. It's not easy, because an investment banker speaks a different language than a researcher. Specialization in one subject helps in managing diverse contacts. You can really get involved in a specific task and task-relevant contacts. Today, my thinking is already more like a banker's thinking than a researcher's.

Vertical differentiation: Delegation of relationship management. In addition to top management specialization, the more successful firms delegated the management of boundary-spanning scientific relationships to senior scientists. A founder of Ligand/H explained, "It is important that I make my [personal scientific] network accessible for everyone working here. This is a task that we pursue in each of our internal team seminars."

Delegating relationship management tasks to employees lower down in the hierarchy contributed to reducing social capital's inertial forces in three ways. First, it enhanced a firm's total capacity to access and actively manage a greater number of more diverse contacts. By delegating some of their tasks and contacts, firm founders could free capacity for themselves. They could concentrate on their leadership role, the firm's strategy, and managerial functions and could establish novel relationships outside the scientific network.

Cytosin↑ took this path after two of the three initial founders left the company and after long debates about the firm's strategy and the role of science in the firm's development. After they had left, Cytosin↑'s remaining founder delegated scientific projects and the management of scientific cooperations to one of the senior scientists and encouraged the others to cultivate their own scientific contacts. Cytosin↑'s founder thus felt free to concentrate on his management task: "We don't run the risk of losing connection to state-of-the-art basic research. Our scientists still like to become involved in the scientific community. That's why I have the time to manage our business contacts." Second, delegating scientific relationships released the firms' founders from their relational obligations toward fellow scientists, because the firms' senior scientists could step in. As one of Proteom/H's founders maintained, "I would not use my time . . . to stand in the lab cooking some compounds or to tend to the many contacts with the scientific community. These are the scientists' tasks." A scientist at Proteom/H was clear about this: "Some of us [scientists] still attend scientific congresses or keep close contact with our former colleagues. In one way or the other [Proteom/H] still serves the [scientific] community. But this is mainly the scientists' job." Third, delegating relationship management expanded the firms' base for learning, both at the level of the scientists and of management. Scientists were expected to develop existing and new scientific

relationships in line with their evolving task requirements. As one of Proteom/H's founders pointed out, "So, a scientist invites a colleague whom he knows. That guest then presents here and people discuss it." A scientist at Proteom/H commented, "It is important to keep in touch with basic research. . . . Imagine, you invent something today and then realize, oh dear, it already exists!" A founder at Ligand/H outlined further implications: "With growth in the number of employees, we added the individual network of each new member. And of course their networks were highly specific to the task that they had to fulfill in the firm." At the same time, delegation made it easier for members of top management to get involved in and continuously to learn from their novel business ties. A founder at Cytosin[↑] argued, "This [delegation] is why I can fully concentrate on my business contacts and don't have to be scientist and manager at the same time. I need this time to engage in my new job as a manager and to understand how the business really works."

The less successful firms, Genom/L and Rezeptor/L, also realized some organizational differentiation within their management teams. In contrast to the successful firms, however, the entrepreneurs in these firms specialized in different research areas and internal research projects but realized no division of labor in managing their firms' external relations. At Rezeptor/L, the creation and maintenance of all external relationships was solely the responsibility of one key founder, which this founder described as "wearing various hats at the same time." At Adenin[↓], a similar situation occurred later in the firm's development. When one of the founders left the firm, one of the remaining two had to take over his relationship management responsibilities. For this person, managing the whole set of the firm's relationships meant that he had to cope with different cognitive schemes, behavior codes, and expectations of external partners. A founder at Genom/L illustrated the challenges involved: "At a trade fair, I represent a company, at the investors' site, I represent a company. At a conference with biologists, I become quite unpopular if I admit to profit-oriented goals with my scientific results." Regularly, this resulted in capacity bottlenecks and role overload as the key founder could not muster the required capabilities and versatility. Consequently, these managers faced the lock-ins described above.

Integration of relationship management. Both the successful and the less successful case study firms regarded it as important to integrate the information and know-how that was flowing from the external relations of individual firm members. To this end, all the firms held frequent internal meetings and facilitated intense informal relationships among their boundary-spanning employees. Our informants characterized cultivating such informal personal contacts as an obvious and feasible measure, as it was not too different from members' experience of the dense internal communication webs of their earlier research groups. With growing firm size, however, it became more difficult and inefficient to exchange information and experiences only through informal meetings. Ligand/H, for example, institutionalized the information exchange by regularly holding formal meetings and by estab-

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lishing cross-functional project teams. Further integrative mechanisms included establishing lateral communication channels among boundary spanners and knowledge management systems. A scientist described this process: "When we find something new in the lab, we immediately send an e-mail to our patent attorney in the legal department. It's an automated process."

Integrative mechanisms such as the aforementioned, however, had very different effects in the more and less successful companies. In firms that retained their closed and cohesive scientific networks, the integrative organizational mechanisms reinforced cohesion and closure, hindered adaptation of the firms' social capital to business development, and thus led to detrimental performance effects. Informants at Genom/L, Rezeptor/L, and Adenin↓ described their weekly team sessions as "relics" from their former times as pure scientists. As Rezeptor/L's founder described it, "Team meetings are important. Members of my research group present novel findings. After that, we discuss. It's like a scientific congress. More intimate, of course." While integrative mechanisms thus effectively spread scientific information and experience within the team, at the same time, they helped to reinforce the lock-ins described above.

In contrast, in those firms that had specialized and delegated their relationship management, the integrative organizational mechanisms were conducive to overcoming individual firm members' lock-ins, for three reasons. First, organizational integration mechanisms facilitated exchanges among organization members who focused on different types of external contacts. They thus exposed specialists for one type of contact to new stimuli and learning experiences that originated in other sets of the firm's external ties. Proteom/H's CSO, for example, described it this way: "You know, scientists sometimes are a bit playful and infatuated with their scientific findings. These discussions [with our CFO] help me to refocus on what is important to our company: scientific progress and profit." Second, integrative mechanisms helped firms avoid possible negative sanctioning by effectively coordinating organization members' actions in relation to different external constituencies. Proteom/H's CSO continued,

Of course, I don't share his [the CFO's] responsibilities and contacts. But it's not that we don't talk to each other. We talk quite often and regularly and share information and experiences. I'm well informed about his activities. And I'm well informed about their implications for my daily business. Just to give you an example: I know immediately when our VC expects progress with our projects or research cooperations—although it's not me who manages investor relations.

Third, as organizational integration helped firms achieve better internal coordination among actors, their overall efficiency in managing their set of external contacts increased. This freed up managerial capacity that could then be invested in forging novel ties and in further developing existing specialized ties.

Data from our cases provide some tentative and partial answers to the question of what drove entrepreneurs to

implement, or not, the noted organizational mechanisms. Clearly, entrepreneurs did not follow a master plan of how to arrange and possibly reconfigure their own and their firms' social capital when entering the business development stage. According to our informants, specialization "evolved historically" (Ligand/H) and resulted from the co-founders' "personal leanings and characters" (Proteom/H). In all the cases we studied, the most important external prompts for change were the product development process and the finance process. At particular points in time, these placed strong demands on the firms to obtain the information and resources necessary to sustain product development processes and secure the financial basis of the firm, respectively. As a consequence, all the firms set out and tried to obtain the needed resources by establishing contacts with partners who might be able to provide them. Important dissimilarities between the more and the less successful firms that may help explain the different paths they chose are small initial differences in historical experience and motivation among the founders. As we showed above, entrepreneurs in the less successful cases shared a strong identity as scientists operating at the frontiers of research. They also confined their private contacts mostly to fellow scientists. In contrast, some crucial actors in the more successful cases had had prior exposure to and interest in different social circles. One was a member of a successful family of entrepreneurs; another had an affinity for dealing with financiers; others had had prior contacts with representatives from the pharmaceutical industry and were interested in further developing these contacts. These small initial differences may have motivated entrepreneurs to specialize in those particular external constituencies with whom they felt most familiar and to leave to others the management of relationships that they felt less capable of managing. The informants themselves apparently did not regard these earlier contacts as important for their firms or as part of their social capital at the time of founding, however, because they did not mention them when we specifically asked for important contacts. Rather than representing differences in social capital, then, these initial differences seem to be small differences in actors' experiences and personal leanings that may have led them to make different decisions than they otherwise might have made about the organization of their firms' management of external relations.

DISCUSSION AND CONCLUSION

This study explored how the configuration, evolution, and organization of entrepreneurial start-ups' social capital affect firm performance. The findings extend research on social capital by identifying the contingent, multilevel effects of different configurations of social capital. In a wider theoretical context, the findings enhance our understanding of the sources of organizational inertia and adaptability. A core theoretical contribution of our research is to show that the organization of relationship management can help to explain the dynamics of start-up development.

Configurations of Social Capital and Their Performance Implications

Our findings spell out which configurations of social capital were more advantageous, and which were less so, for firm development during the early start-up and subsequent business development stages. In their start-up phase, all the new biotechnology firms had realized a configuration of their social capital that was characterized by cohesion and closure based on norms of reciprocity and shared cognitive schemes among a limited set of partners, mostly in the scientific community. In line with earlier research, our findings suggest that the cohesive configuration of social capital fosters the successful emergence and take-off of firms (Larson and Starr, 1993; Oliver and Liebeskind, 1998). Extending earlier studies, our study further reveals that the very configuration of a firm's social capital that is conducive for a firm's start-up hinders its performance in the subsequent business development phase. This is because the strong and cohesive ties within the scientific community that were crucial for a successful start-up for the new biotechnology firms could not provide the information and resources needed to further develop the firm.

In contrast, firms that were more successful in the business development phase managed to retain the quality of their established ties in the scientific community and, at the same time, develop new cohesive ties with other constituencies that could serve the firm's evolving information and resource needs. In aggregate, the cohesive ties of individual organizational members who each specialized in relations with a particular constituency resulted in a more differentiated and complementary composition of social capital at the firm level. This configuration of firms' social capital proved advantageous for their performance because they thus had the capacity and capability to connect effectively with a more diverse set of external partners in a broad range of important firm constituencies and to gain access to the information and resources that these partners possessed.

These findings have several implications for theory. First, they underscore the importance of applying a contingent view when studying the value of social capital (Burt, 1997). In their early start-up phase, firms need to meet different resource and information needs than in their business development stage (Kazanjian, 1988). As our study shows, whether or not firms manage to align the configuration of their social capital so that it accommodates their changing resource needs has significant performance consequences. It thus seems important for both theory and managerial practice to be concerned about the factors that constrain and enable firms to adapt their social capital to align it with changing information and resource requirements.

Second, our findings demonstrate that it is fruitful for researchers to consider the interplay between levels of analysis when studying the effects of social capital, as suggested by Ibarra, Kilduff, and Tsai (2005). Social capital is generated, maintained, and drawn upon by individuals (Burt, 2000). For understanding the firm-level outcomes of individual organiza-

tion members' social capital, however, the firm-level configuration and management of organization members' social capital matters. As our study shows, strong and cohesive individual-level ties can have very different consequences for firms depending on whether they result in a homogenous or in a differentiated composition of social capital at the firm level. Furthermore, our study suggests that the range of ties at the firm level is an important moderator for the firm-level effects of strong and cohesive individual-level ties. Both the homophilous and the differentiated configurations of firm-level social capital allowed firms to exploit the learning, reputation, and cooperation benefits of the close and cohesive ties that their members cultivated individually (Uzzi, 1997), yet only the firms entertaining a wider range of close external relations with diverse partners could access the broader array of information, resources, and opportunities they needed for their continued development.

Third, these findings add to the ongoing debate about the relative importance of network closure (Coleman, 1988) and range (Burt, 1997) for the value of social capital. According to one view, the benefits of cohesion and closure can only be achieved at the expense of the benefits of range, and vice versa, while according to another, the two phenomena are compatible. Burt (2000) reasoned that the two arguments could be brought together by positing that range is the source of added value, while cohesion and closure are critical to realizing this value. Reagans, Zuckerman, and McEvily (2004) argued that closure and range can have simultaneous yet distinct effects if applied to the internal and external relations of a group, respectively. Our study suggests that cohesion and range can have simultaneous yet distinct effects at different levels of analysis. Our cases provide evidence that firms can appropriate, at the same time, both the benefits of strong, cohesive ties with a small range of similar partners at the level of individual organizational members' social capital and the opportunities provided by a wider range of ties with different constituencies at the firm level.

Dynamics of Social Capital: Implications for Organizational Inertia and Adaptability

We know little about how social capital evolves over time, about the factors that influence its dynamic, and about related implications for performance (Baum, Calabrese, and Silverman, 2000). Previous research has reported a strong tendency among entrepreneurs to team with partners with similar characteristics, such as gender, education, status, or beliefs (McPherson, Smith-Lovin, and Cook, 2001; Ruef, Aldrich, and Carter, 2003). Research has also found that firms have a tendency to continue to engage with those partners with whom they had satisfactory relations in the past (Uzzi, 1997; Chung, Singh, and Lee, 2000). Our findings suggest that inertia in partner selection is nurtured by a particular configuration of firms' social capital that fosters relational and cognitive lock-in. Specifically, our study spells out why and how close and cohesive relations that are based on reciprocity constrain individual organizational members' capacity, incentives, and competence to reconfigure their ties and thus promote inertia in social capital. Our study further reveals how firms can over-

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come those inertial forces by enhancing the capacity, incentives, and competence of their members. Previous researchers have maintained that structural holes and network dispersion can help organizations and their members overcome network cohesion and closure (Gargiulo and Benassi, 1999; Uzzi and Gillespie, 1999). Our research closes a gap in this literature by explicating the factors and processes that enable and constrain actors as they realize a new configuration of their social capital, from network cohesion and closure to differentiation of the network.

A core theoretical contribution of our study to the literature is in showing that firms' organization of relationship management is important for understanding the dynamic links between individual and firm-level social capital and firms' performance outcomes. Specifically, our findings suggest that when firms have a low degree of specialization and delegation in the management of their members' close and cohesive ties, attempts to extend the range of ties are likely to fail, and actors will eventually succumb to the inertial forces associated with closure and cohesion. This is primarily due to quantitative and qualitative role overload and the inertial forces of individual actors' established relations, shared norms, and cognitions. In contrast, a greater degree of horizontal and vertical differentiation in organizing the management of their external relations enhances the organization's capacity so that firms can develop and manage a greater number of and more heterogeneous external relations. Moreover, specialization in and delegation of responsibility for particular types of partners induce motivational and learning processes that, over time, enable organization members to open up the cohesive structure of their established relations, transform established cognitive schemes, and develop close and strong relations with new constituencies. Finally, we found that procedures designed to help firms integrate the information and resources that are provided by their external partners made it easier for them to exploit the differentiated and complementary portfolio of their members' external relations. But when firms' social capital was more homogeneous, organizational integration also reinforced the relational and cognitive lock-in and their ensuing detrimental performance effects.

These findings enhance our understanding of the antecedents and consequences of the evolution of social capital. First, they suggest that the internal organization and management of a firm's external relations is an important antecedent of organization members' and their firms' social capital. This is a noteworthy contribution, as to date we know very little about the factors that may explain variations in the configuration of social capital across actors. Second, our findings suggest that how a firm organizes its relationship management importantly drives and constrains its members' and the firms' ability to adapt their social capital to changing needs. Our study thus outlines one way in which firms can influence the dynamic of their members' and the firms' social capital. Third, our study suggests that the organization of firms' relationship management is a mediating and moderating variable that helps us both to understand how organiza-

tion members' social capital accrues to the firm-level and to predict related firm-level outcomes. Finally, our study provides preliminary evidence that a dynamic coherence between a firm's social capital and its evolving resource needs fosters firm performance (Hite and Hesterly, 2001). To understand the origins, development, and outcomes of firms' social capital more fully, it might be fruitful not only to look at various characteristics of firms' external networks, as is prevalent in the literature, but also to consider the impact of firms' internal organization.

From a broader perspective, our findings also contribute to understanding the sources of organizational inertia and adaptability. Organizational inertia has been used to describe a firm's resistance to fundamental reorientations in its policies, structures, and processes (Hannan and Freeman, 1984). Research has noted various factors that make organizations subject to inertial tendencies, among them local search behavior (Cyert and March, 1963), organizational routines (Nelson and Winter, 1982), competency traps (Leonard-Barton, 1992), and external pressures to signal reliability and accountability (Hannan and Freeman, 1984), as well as liabilities of organizational change (Amburgey, Kelly, and Barnett, 1993) that reduce operational efficiency (Haveman, 1992) and diminish an organization's ability to mobilize resources (Hannan, Pólos, and Carroll, 2003). Yet we still know fairly little about the factors that may be responsible for variations in organizational inertia. One important research finding is that organizational inertia increases with firm age (Baum and Mezias, 1992; Barron, West, and Hannan, 1994). Miller and Chen (1994) found that good past performance contributes to organizational inertia, while diversity of the markets served by a firm discourages it. Our study shows why and how a firm's social capital can be a source of organizational inertia as well as an enabler of organizational development, depending on the firm-level configuration of social capital. Our findings thus suggest that the configuration of firm-level social capital, among other factors, can contribute to explaining variations in organizational inertia and adaptability across organizations.

Organizational adaptability denotes the capacity of an organization to change its policies, structures, and processes to meet novel challenges and opportunities. In explicating how firms can overcome the inertial forces inherent in their start-up social capital and adapt their external relations to be able to meet new resource requirements, our study builds on and extends the classic argument by Lawrence and Lorsch (1967). They suggested that organizational differentiation, i.e., the segmentation of the organizational system into subsystems, allows each subsystem to develop attributes and behaviors that fit the particular requirements posed by its relevant external environment. Organizational integration is the process of achieving a unity of effort among the various organizational subsystems toward accomplishing organizational tasks. As Lawrence and Lorsch (1967) maintained, we found that firms performed better if they managed to differentiate and integrate their internal structures in line with the requirements of their task environments. In the early start-up phase,

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new biotechnology firms could satisfy their resource needs by aligning their social capital mainly with a relatively homogeneous environment dominated by actors from science, whereas in the business development phase, those firms in which social capital provided access to the resources of a broader and more differentiated set of external constituencies fared relatively better than those firms that retained their homophilous scientific networks of the start-up phase.

Our research extends Lawrence and Lorsch's argument (1967) in two ways. First, it indicates that a firm's social capital mediates the relation between organizational differentiation and integration, on the one hand, and organizational adaptation, on the other. Second, our study adds a generic explanation to the common functional explanation of organizational differentiation and integration. It suggests that the subsystem differentiation of larger organizations may originate in individual firm founders specializing in and delegating responsibility for different external constituencies that can provide needed resources for continued firm development. In our cases, the mechanisms of organizational integration that management used can be traced back to routines and experiences in the founders' prior institutional contexts.

Our study demonstrates that a firm's social capital has an impact on organizational adaptability. Through its social capital, an organization accesses the information and resources that then enable it to adapt to novel opportunities and challenges. Our study illustrates that over the course of firm development, organizational adaptability depends on an organization's ability to reconfigure its social capital to align it with evolving resource and information needs. The social capital literature has mainly discussed how structural and relational characteristics of actors' social capital affect various elements of organizations' adaptability, such as learning (Reagans and McEvily, 2003), product and technological development (Yli-Renko, Autio, and Sapienza, 2001), and information about future demand and customer preferences (Uzzi, 1997). Our research highlights the additional significance of the cognitive dimension in its interplay with the other two dimensions of social capital. It thus contributes to emerging work on the dynamic relations among network structures, social identity, and actors' cognitions (Ibarra, Kilduff, and Tsai, 2005). Our findings show that it was low adaptability, the consequence of a self-reinforcing reciprocal relationship between scientists' professional identity, and the structural and relational features of their social relations that led to inertia in social capital. Firms enhanced organizational adaptability when they made changes in the structure of their relationship management that partly disrupted existing identity-based relations and provided organization members with opportunities and incentives to engage repeatedly with counterparts from different professional backgrounds. As a consequence of the new structure and content of their social relations, actors' professional identities evolved over time, and they developed more business-oriented cognitive schemes. This cognitive adaptation in turn allowed actors to deepen their relations with their external counterparts. As a result, firms were in a better position to identify and access the informa-

tion and resources needed for continued business development.

Future Research Opportunities

Although this research has contributed to our understanding of the drivers of and constraints on firms' social capital, adaptive capacity, and ensuing performance implications, it is not without limitations. Because our analysis rests on case studies in a single industry, more extensive studies in other settings are required to test the generalizability of our argument. Nevertheless, we believe that our exploratory study has generated some results that might be fruitful for theory and may thus warrant further scrutiny. Similarly, we identified some factors that can help explain variations in the configurations of actors' social capital, but future research could examine more fully the historical origins of individuals' and firms' social capital (Portes, 1998). In studying the implications of social capital, future research could devote more attention to studying with whom actors connect, and to which resources they can thereby potentially gain access, rather than examining only how actors connect. Furthermore, our research has joined the few voices that have expressed some reservations about an overly positive view of social capital by highlighting that a firm's social capital can be an asset but may also turn into a liability for future development. Accordingly, our findings encourage research that further explores the contingencies under which social capital becomes an asset or a liability. This study should provide a fruitful starting point for future research that further explores factors and processes that influence the development and value of social capital over time.

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