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## The impact of network capabilities and entrepreneurial orientation on university spin-off performance

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### Abstract

Drawing on a database of 149 university spin-offs, we investigated the impact of network capability (NC), defined as a firm's ability to develop and utilize inter-organizational relationships, and entrepreneurial orientation (EO) on organizational performance. Not only do the results suggest that a spin-off's performance is positively influenced by its NC, but the findings also indicate that a spin-off's EO fosters competitive advantages. Although no direct relationship is apparent between EO and sales growth, sales per employee, or profit attainment, moderated hierarchical regression analyses reveal that NC strengthens the relationship between EO and spin-off performance. In sum, our research shows that a spin-off's organizational propensities and processes that enhance innovation, constructive risk taking, and proactiveness in dealing with competitors *per se* do not enhance growth and secure long-term survival. However, we found that NC moderates the relationship between EO and organizational performance.

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**Keywords:** Entrepreneurial orientation; Network capability; University spin-off; Technology transfer; Academic entrepreneurship

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## 1. Executive summary

University spin-offs, usually formed to commercialize technologies originating from publicly funded research institutions, may effectively contribute to economic prosperity and job creation. Although there is increasing interest in academic entrepreneurship and entrepreneurial orientation, little empirical research identifies organizational properties that foster the growth and long-term survival of university spin-offs.

Drawing on a database of 149 university spin-offs, we investigated the impact of network capability (NC) and entrepreneurial orientation (EO) on organizational performance. NC comprises a firm's abilities to develop and utilize inter-organizational relationships to gain access to various resources held by other actors. Four dimensions of NC are distinguished: coordination, relational skills, market knowledge and internal communication. EO represents a strategic orientation that describes a firm's organizational autonomy, willingness to take risks, innovativeness, and proactive assertiveness. NC and EO are predicted to directly contribute to the performance development of spin-offs.

Our study shows that the performance variables sales growth, sales per employee, profit attainment, perceived customer relationship quality, realized competitive advantages, and long-term survival, are influenced by a spin-off's NC. The results of this research highlight two issues. First, they support the recent arguments of entrepreneurship scholars that networks are important for spin-off success. Second, as we have analyzed networking ability, and not only the existence of a network, we contribute an insight motivated from the capability-based view of the firm: university spin-offs perform better with an increasing degree of network capability. Given the four dimensions, managerial attention should focus on increasing coordination, relational skills, market information and internal communication in order to develop NC, thereby contributing to spin-off success. All of these dimensions are manageable and directly relevant to implementation efforts.

EO was not found to have a significant direct effect on sales growth, sales per employee, and profit attainment, leading to the conclusion that the existence of EO per se does not promote financial growth of a spin-off. These results support the general notion that the EO–performance relationship depends on the context in which it occurs. This suggests that an overstated interest in EO by such actors as venture capitalists might be misleading. However, this study demonstrates the highly significant direct effect of EO on the realization of competitive advantages and the moderately significant effect on perceived customer relationship quality. EO enables an academic spin-off to aggressively compete with competitors, thereby offering customers valuable innovative products and services that may promote a long-term commitment.

Furthermore, NC moderates the relationship between EO and spin-off performance. We found that the two variables interact significantly on sales growth, sales per employee, profit attainment, realized competitive advantages, and long-term survival. Thus, NC strengthens the relationship between corporate EO and spin-off performance. These results further emphasize NC, and its analysis and development in spin-offs.

These results have important implications for the management of university spin-offs. Firms should note that an entrepreneurial orientation, in and of itself, is not enough to compete in today's markets. EO is an entrance ticket that allows for a higher impact of competencies on performance. Entrepreneurial ambitions alone do not create value and

should not be seen as the fundamental force for the sustainable prosperity and growth of spin-offs.

We suggest that firms develop their network capability and their networks as a means to improve performance. One possibility is to engage experienced and well-known business people. Some governmental agencies and venture capitalists run mentor programs that aim at the development of networks. Another issue is to make resources for networking available and to empower employees to develop relationships.

## 2. Introduction

University spin-offs can be seen from different perspectives: as sources of employment (Pérez and Sánchez, 2003; Roberts, 1991a), as mediators between basic and applied research that enable their customers to compete on the technological forefront (Autio, 1997), as contributors to higher innovation efficiency (Rothwell and Dodgson, 1993) and to a regions' economic development (Mian, 1997), or as change agents of the economic landscape moving traditional boundaries between basic and applied research (Abramson et al., 1997; Roberts, 1991b). Spin-offs are confronted with a number of serious obstacles. Academic firms struggle to establish close links to customers and suppliers after their spinout (e.g., Pérez and Sánchez, 2003; Stuart et al., 1999), and failure rates of alliances and collaborative agreements can reach 70% (Duysters et al., 1999; Park and Ungson, 2001). Academic interest has recently focused on the ability of firm characteristics to explain differences in alliance success. Such characteristics include alliance capability (Kale et al., 2000), relational capability (Lorenzoni and Lipparini, 1999), and network capability (Anand and Khanna, 2000). Although a number of studies have examined the relational capabilities of firms, no study has focused explicitly on a university spin-off's ability to manage business networks. This paper closes this gap by focusing on spin-offs' capabilities to develop, maintain and use business relationships and strategic alliances.

Entrepreneurial aspects such as opportunity identification, risk taking, and resource mobilization have been highlighted as critical success factors for academic spin-offs (Roberts, 1991a; Steffensen et al., 1999), where entrepreneurial behavior is believed to stimulate growth and economic performance. Entrepreneurship is regarded as crucial to bridging gaps between the research and business worlds (Abramson et al., 1997). Based on that assumption, representatives of industry, government and science increasingly challenge academics to transfer their research results to companies in an entrepreneurial fashion (Doutriaux, 1987; Franklin et al., 2001). However, few empirical studies have analyzed the impact of a spin-off's entrepreneurial characteristics on its performance. Case studies of academic spin-offs conducted by Bray and Lee (2000), Pérez and Sánchez (2003), and Steffensen et al. (1999) provide some evidence that a match of entrepreneurial ambitions and marketing abilities characterizes successful spin-offs. However, no study has focused specifically on the relationship between a university spin-off's network capability and entrepreneurial behavior.

Entrepreneurship is often said to exist in a firm that "engages in product market innovation, undertakes somewhat risky ventures and is first to come up with 'proactive'

innovations, beating competitors to the punch" (Miller, 1983, p. 771). Prior theory and research acknowledge entrepreneurial orientation as an important constituent for organizational success (Lumpkin and Dess, 1996). Many authors argue that entrepreneurial behavior is vital for firms of all sizes to prosper in competitive environments (Covin and Slevin, 1988; Lumpkin and Dess, 1996; Miller, 1983; Zahra, 1993a). However, empirical studies indicate that the relationship between a firm's entrepreneurial orientation and desired organizational outcomes, like sales growth and profitability, is not as straightforward as often assumed (e.g., Covin and Slevin, 1990; Dess et al., 1997). Obviously, an entrepreneurial orientation per se is not necessarily desirable in all situations (Covin and Slevin, 1988). The success of entrepreneurial orientation may be affected by the firm's organization structure, corporate culture, and/or environmental dynamism.

Many entrepreneurship studies postulate a strong EO–performance relationship, especially in hostile and/or technologically sophisticated environments (e.g., Naman and Slevin, 1993; Covin and Slevin, 1998). Such environments can be assumed for university spin-offs and, therefore, we assume that EO is important to the growth and profitability of academic spin-offs. The commercialization of new technologies is usually characterized by intense innovative competition (Shan, 1990). In several cases, spin-offs have to develop their own markets because they are offering a unique product or service addressing the needs of only a few customers (Olofsson and Wahlbin, 1984; Pérez and Sánchez, 2003; Rodenberger and McCray, 1981). As such, spin-offs challenge existing markets and technological standards, try to gain other firms' customers and, thus, attack fortified hills. Therefore, spin-offs very often undertake an entrepreneurial behavior outlined by Schumpeter (1934) as "creative destruction." At the same time, exploitative behavior is not necessarily a common characteristic of university scientists starting or leading a venture (Van Dierdonck and Debackere, 1988). In addition, academic spin-offs are frequently monitored by potential competitors, firms that may be capable of imitating products and/or services quickly on a large scale—or simply acquire the firm. Thus, we believe that entrepreneurial orientation is a crucial characteristic of university spin-offs. This paper addresses this question and investigates relationship between entrepreneurial orientation and performance in university spin-offs.

The paper also examines the moderating effect of network capabilities on the entrepreneurial orientation–performance relationship. Entrepreneurship scholars have emphasized the need to go beyond the investigation of bivariate correlations between entrepreneurship and performance variables (Covin and Slevin, 1991; Lumpkin and Dess, 1996) to reduce misleading inferences about the entrepreneurship–performance relationship. Therefore, a contingency model for examining the alignment among the key constructs is developed.

In relation to our research question – the impact of NC and EO on performance – we argue that the analysis of university spin-offs contributes to an understanding of this matter because (1) a great variety of degrees of NC and EO among university spin-offs can be assumed, and (2) the impact of NC and EO should be high given the market conditions in which these firms are operating. The remainder of the paper is organized as follows: after the development of hypotheses, our ideas are tested on a sample of spin-offs from higher education institutions before the implications of our study are discussed.

### 3. Theoretical background and hypotheses

University spin-offs are important means of commercializing technologies and represent a mechanism of wealth creation (Roberts and Malone, 1996). University spin-offs, sometimes referred to as university spin-outs (Smilor, 1990) or academic spin-offs (Nlempvo Ndonzuau et al., 2002), are business ventures that (1) are founded by one or more academics who choose to work in the private sector (at least part-time) (Doutriaux, 1987), and (2) transfer a core technology from the parent organization (Samson and Gurdon, 1993; Steffensen et al., 1999). Spin-offs contribute to technology transfer in two stages. First, they transfer technology from their parent organization to themselves and, second, they transfer the technology to customers (Pérez and Sánchez, 2003).

The establishment and success of academic spin-offs are a complicated matter. Studies have examined different aspects, such as the characteristics and programs of parent organizations (Bray and Lee, 2000; Rappert and Webster, 1997; Rogers et al., 2001; Smilor, 1987), spin-off/parent conflicts (Steffensen et al., 1999), government policies (Liu and Jiang, 2001), barriers to technology transfer (Geisler and Clements, 1995; Pérez and Sánchez, 2003; Van Dierdonck and Debackere, 1988), spin-out processes (Jones-Evans et al., 1998; Roberts and Malone, 1996), founder qualities (Klofsten and Jones-Evans, 2000; Samson and Gurdon, 1993), entrepreneurial team formation (Clarysse and Moray, 2004), and characteristics of technologies, industries, and/or markets (Chiesa and Piccaluga, 2000; Nerkar and Shane, 2003; Shan, 2001). In addition, a great deal of research focuses on the network relations of spin-offs or social networks, the results of which indicate that a developed network of strong relationships with various partners may be an advantage (Hoang and Antoncic, 2003). Close relationships provide entrepreneurs and their organizations with avenues for negotiation and persuasion, enabling them to gather a variety of resources (e.g., market information, ideas, problem solving, social support, venture funding, and financial resources) held by other actors (Hoang and Antoncic, 2003; Johannesson and Monsted, 1998; Nicolaou and Birley, 2003a,b; Shan and Stuart, 2002).

As the portion of a firm's value creation derived from relationships with network partners has grown (Dyer and Singh, 1998) and as firm value is influenced by alliance activities (Anand and Khanna, 2000; Kale et al., 2002), scholarly and managerial interest in capabilities that enable firms to succeed in networks has increased. Firms are widely recognized as being embedded in networks of social, professional, and exchange relationships with other actors (e.g., Granovetter, 1985; Gulati and Gargiulo, 1999). From the perspective of a single firm, a network encompasses a set of relationships with various organizations, including customers, suppliers, competitors, or public research institutions, relationships that are connected with each other and create a wider network structure (Cook and Emerson, 1978). From this perspective, firms are no longer considered as individual, self-fulfilling units that prefer transactional arrangements, the view normally applied in transaction cost theory (Williamson, 1975) and traditional industrial organization theory (e.g., Porter, 1987). Kale et al. (2000) use the notion of relational capital to express the quality of a network. Their study suggests that a fruitful balance between learning critical capabilities from partners and protecting firm-specific competencies leads to the development of friendship, respect, and trust between interacting parties.

However, value creating, inter-organizational ties between organizations do not simply exist or emerge. The transfer of know-how between network partners is fraught with ambiguity and interactions can rarely be pre-specified. Moreover, networks may have negative implications, locking firms into unproductive processes where know-how and other resources are wasted (Gulati et al., 2000). Sometimes, relationships and alliances persist beyond their useful lifespan, failing to serve the strategic interests of the partners (Inkpen and Ross, 2001). Partners may also engage in opportunistic behavior only to outlearn each other (Hamel and Prahalad, 1994; Williamson, 1981).

Anand and Khanna (2000) argue that firms have to learn to manage their partnerships to be able to cope with contingencies resulting from intangible personal, organizational, and cultural attributes. Thus, one of our major contentions is that once an academic firm is spun out, its performance can be more fully understood by examining its abilities to build trustful relationships, to integrate the resources of external partners and to synthesize its activities with those of network partners.

Scholars have taken several theoretical viewpoints, including the knowledge-based theory (Conner and Prahalad, 1996; Grant, 1996), the resource-based theory (Barney, 1991; Wernfeld, 1984), and the dynamic capability perspective (Eisenhardt and Martin, 2000; Teece et al., 1997), to develop an understanding of capabilities that enable firms to grow and prosper in relational settings like dyadic business relationships (Anderson and Narus, 1990; Dyer and Singh, 1998), strategic alliances (Anand and Khanna, 2000; Kale et al., 2002), joint ventures (Merchant and Schendel, 2000; Reuer and Koza, 2000), and industry networks (Dyer and Nobeoka, 2000; Gulati, 1998). A capability is seen as a special type of resource that is organizationally embedded and nontransferable, and that improves the efficiency and effectiveness of other resources possessed by the firm (Eisenhardt and Martin, 2000; Makadok, 2001; Teece et al., 1997).

Several approaches have been suggested to capture a firm's network capability. Kale et al. (2002) define "alliance capability" as a composite of alliance experience and the existence of a dedicated alliance function, which focuses on the more structural set-up of the firm. Similarly, "network capability" has been measured by the number of previous alliances, even though the theoretical development of the construct itself more reflects the learning perspective (Anand and Khanna, 2000). Lorenzo and Lipparini (1999) regard "relational capability" as the capability to interact with other companies, a capability that is based on absorption, combination and coordination. Ritter and Gemünden (2003) argue that "network competence" is a firm's ability to develop and use inter-firm relationships, which can be measured by task execution and qualifications. However, the exact content of such a capability is still not studied in detail (Gulati, 1998; Kale et al., 2002).

In this study, we define a spin-off's network capabilities (NC) as its abilities to initiate, maintain, and utilize relationships with various external partners. The term "network" therefore expresses that managing relationships goes beyond coping with single relationships and alliances (for dyadic capabilities, see, e.g., Lambe et al., 2002; Sivadas and Dwyer, 2000; Spekman et al., 2000). Furthermore, the use of the word "capabilities" signals that NC is understood as dynamic processes and a higher order resource (Amit and Shoemaker, 1993; Teece et al., 1997). This usage is similar to discussions on competencies as series of activities and a process (Li and Calantone, 1998). Network capability is further defined as an organization-wide characteristic. By applying this

perspective, we also focus on internal procedures and tools that enable a spin-off to relate to other firms. Based on the contributions of a dedicated alliance function, four components of network capability can be identified (Kale et al., 2002): coordination, relational skills, partner knowledge, and internal communication. These components support each other. For example, a high degree of partner knowledge and internal communication enables good coordination between partners, high levels of coordination and relational skills allow a spin-off to increase its partner knowledge, internal coordination enables collection of various pieces of information for better partner knowledge. We therefore treat NC as a composite that requires a formative measure because we conceptualize NC as a higher order resource that increases in magnitude as each of the four NC components increases.

Coordination between collaborating firms has been highlighted in many dyadic studies (Mohr and Spekman, 1994), while cross-relational coordination has also been suggested (Walker et al., 1997). Coordination activities are boundary-spanning activities (Adams, 1980) connecting the firm to other firms and connecting different individual relationships into a network of mutually supportive interactions.

Relational skills, also referred to as social competence (Baron and Markman, 2003), are also seen as important to the management of relationships because business relationships are very often inter-personal exchange situations. A spin-off's management has to perceive and adapt to a variety of social situations, and must be able to respond to a broad range of information and social stimuli from inside and outside the organization. Relational skills include such aspects as communication ability, extraversion, conflict management skills, empathy, emotional stability, self-reflection, sense of justice, and cooperativeness (Marshall et al., 2003).

Many studies have highlighted the importance of market knowledge—defined “as organized and structured information about the market” (Li and Calantone, 1998). In the context of this study, we focus on partnering and, therefore, define partner knowledge as organized and structured information about a firm's upstream and downstream partners (suppliers and customers), and competitors. Spin-offs with knowledge about their partners can shape appropriate exchange routines and governance structures, and these firms can avoid or handle instabilities in their partnerships (Das and Bing-Sheng, 2000). Partner knowledge allows for situation-specific management with a partner, such as the reduction of transaction control costs, and a proactive and solution oriented conflict management. Overall, partner knowledge stabilizes a firm's position where necessary within a network. This knowledge is a pre-requisite for effective coordination between parties where, at the same time, it develops by coordination and internal communication. As such, it becomes an integrated part of NC.

Internal communication is also included in the concept of network capability. Studies on market orientation have continuously shown that internal communication is essential for being responsive and open (Kumar et al., 1998; Narver and Slater, 1990), and for effective organizational learning within partnerships (Doz, 1996). From a relational perspective, Sivadas and Dwyer (2000) also point to internal communication as an integrated part of collaborative competence. Assimilating and disseminating up-to-date information on partners, their resources and agreements with them to all involved departments help to avoid redundant process and miscommunication as well as improve

the detection of synergies between partners (Cohen and Levinthal, 1990). Firms must connect their many external relationships internally.

Network capability enables a firm to connect its own resources to those of other firms by building relationships. On the customer side, relationships are important means of learning about customer needs in order to develop marketable offerings. One reason is that technology transfer is mostly an intangible asset transfer that requires mutual trust (Pérez and Sánchez, 2003). Network capability, as a mechanism for anticipating market opportunities, leads to a more focused, market-oriented resource deployment. In addition, customers need to be educated in the use of innovative products, which again requires interaction between the seller and the buyer.

On the supplier side, relationships are important to ensuring timely and state-of-the-art input that is of notable importance to knowledge based firms, such as spin-offs. The locus of innovation should be seen in networks, rather than in individual firms or individual employees (Håkansson, 1989). Due to the increasing complexity of technologies, capabilities needed and risks implied, firms increasingly opt for collaborative innovation. This also allows firms to focus on their core activities and interlink these with other firms' resources. Cooperative competencies play an important role in fostering the success of this process (Sivadas and Dwyer, 2000). Furthermore, good relationships deal with variations in demand by adapting outsourcing agreements.

University spin-offs with a strong technological orientation or those which have decided not to grow over a certain size may not have the in-house capacity to supply the (potential) market with a new technology. Collaboration enables a spin-off to bring a product to the market faster and to cover larger regions. Due to their technological orientation, spin-offs may encounter problems in market sensing and market intelligence, particularly when dealing with foreign markets. Spin-offs therefore need reliable market partners to develop presence and reputation in these critical stages. Close relationships to high-status partners may provide young ventures with attributions of quality and reliability when their own actual quality is rather uncertain (Stuart et al., 1999). Therefore, the existence and growth of spin-offs depend on their ability to make important and purposeful connections to such actors as suppliers, customers, research institutions, and legal authorities. In this context, NC is key to creating a sustainable win-win situation because only networks with perceived fair value sharing can prosper in the long term. NC balances the danger of out-learning and being out-learned by developing a mutual understanding for the benefit of the spin-off and its network partners. This leads to our first hypothesis:

**Hypothesis 1.** Network capability is positively associated with spin-off performance.

Although the entrepreneurship literature remains imprecise (Stevenson and Jarillo, 1990), most authors accept that all types of entrepreneurship are based on innovations that necessitate changes in resource development and the creation of new capabilities to pursue opportunities (Stopford and Baden-Fuller, 1994). In strategy-making process literature, contemporary entrepreneurship research considers entrepreneurship as a firm-level phenomenon (e.g., Barringer and Bluedorn, 1999; Covin and Slevin, 1991; Stevenson and Jarillo, 1990; Zahra, 1993b) that occurs as a result of the interaction among individuals and groups at multiple levels within the firm (Burgelman, 1983). A basic assumption is

that a firm's behavior can be classified along a conceptual continuum that ranges from highly conservative to highly entrepreneurial (Barringer and Bluedorn, 1999). A firm's position on this continuum describes its entrepreneurial orientation (Lumpkin and Dess, 1996), alternatively referred to as its entrepreneurial posture (Covin and Slevin, 1990), entrepreneurial style (Naman and Slevin, 1993), or corporate entrepreneurship intensity (Barringer and Bluedorn, 1999).

Generally, entrepreneurial orientation refers to the propensities, processes and behaviors that lead to entry into new or established markets with new or existing goods or services (Lumpkin and Dess, 1996). Based on various models of firm-level entrepreneurship (e.g., Covin and Slevin, 1990, 1991; Miller, 1983; Miller and Friesen, 1978; Mintzberg, 1973), Lumpkin and Dess (1996) have developed five key features that characterize a firm's entrepreneurial orientation (EO): autonomy, risk taking, innovativeness, proactiveness, and competitive aggressiveness. Autonomy is the degree to which organizational players (individuals, teams) remain free to act independently, to make key decisions, and to pursue opportunities. Risk taking reflects a firm's proclivity to support projects in which the expected returns are uncertain. Innovativeness indicates a firm's tendency to support new ideas and to foster creative processes that are aimed at developing new products and services. Taking initiative by anticipating and pursuing new business opportunities and by participating in emerging markets is often referred to as proactiveness. Competitive aggressiveness is the notion of challenging competitors to achieve market entry or to improve position. In contrast to firms with high corporate entrepreneurship, firms adopting a conservative orientation are considered as risk-averse, less innovative, and primarily passive in developing new markets and business opportunities (Miller and Friesen, 1982).

The entrepreneurship–performance relationship has been a research interest over the past three decades (Zahra et al., 1999a). Zahra et al. (1999b) have argued that entrepreneurship improves a firm's overall learning and drives the wide range of knowledge creation that builds and reconfigures the sources of its competitive advantage. Empirical results suggest that corporate entrepreneurship improves firm performance by increasing the company's proactiveness and risk taking, and by promoting product, process, and service innovations (e.g., Lumpkin and Dess, 1996; Zahra, 1991, 1993b).

Creativity, an independent spirit, and a whole-hearted commitment to new ideas are important impetus to entering new or established markets with new or existing products or services (Lumpkin and Dess, 1996). A proactive firm is a leader rather than a follower, given its willingness and foresight to seize new opportunities (Covin and Slevin, 1990). First mover advantages are emphasized as the best strategy for capitalizing on a market opportunity. Usually, first movers can capture high profits and are able to establish a corporate reputation as a technological leader. Achieving competencies in the latest product technologies and the development of advanced production processes may lead to a superior market performance (Porter, 1980). Setting ambitious market-goals, doing things differently, and redefining products and services are considered to be effective means to pursue competitors (Porter, 1987). Therefore, we propose the following hypothesis:

**Hypothesis 2.** A high degree of entrepreneurial orientation has a positive effect on a spin-off's performance.

Entrepreneurship research has highlighted the importance of studying organizational factors, such as firm resources, organizational structure, culture, and top management team characteristics, to further understand the entrepreneurship–performance relationship (Covin and Slevin, 1991; Lumpkin and Dess, 1996; Zahra, 1993b). Several empirical studies have supported the contention that the entrepreneurship–performance relationship is mediated by the organizational context (e.g., Covin and Slevin, 1988, 1990; Dess et al., 1997). This study examines the moderating effects of NC on the EO–performance relationship. NC is conceptualized as a firm-level concept (Kale et al., 2002) that promotes market and partner-oriented behavior. As such, NC affects a broad array of activities within an organization and across its boundaries and, therefore, has the potential to moderate the contribution of other advantage sources to performance. We assume that NC advances the effectiveness and efficiency of entrepreneurial orientation.

Activities and resources that constitute a firm's NC can be seen as contextual factors that may enhance strategic assets and facilitate processes that enable the firm to behave proactively and innovatively in a more effective way (Covin and Slevin, 1991). A network-capable firm will be more likely to attain superior performance based on new products and services, as it continually monitors customer preferences and competitor actions, disseminating this information throughout the organization and within the supplier network (Han et al., 1998). Given the increasing importance of customer orientation, activities that integrate potential customers into the innovation process may serve as a basis for selling innovative products and services to customers ahead of competition (Maidique and Zirger, 1984). Networking firms are better able to anticipate new preferences, are aware of competitors' actions quickly, and can either develop new market offerings when competitor copying becomes apparent or can imitate their innovations. Furthermore, internal communication and social competencies that foster an adequate implementation climate (Klein and Sorra, 1996), like empathy and conflict management skills, are also useful for successful completion of internal innovation processes. Highly entrepreneurial-minded firms, like prospectors, are innovative risk takers striving aggressively for competitive advantages and growth (Miles and Snow, 1978). Growth mainly comes from development of new markets, expansion of product and service offerings, and customer satisfaction. Therefore, EO should lead to better performance when the firm concentrates on customer (latent) needs and employs mechanisms for adaptation, knowledge transfer, and relationship development. Stated formally:

**Hypothesis 3.** The relationship between a spin-off's entrepreneurial orientation and its performance will be moderated by network capabilities. Increased levels of network capabilities will increase the contribution of entrepreneurial orientation to performance.

#### **4. Empirical study**

##### *4.1. Data collection and sample*

The research sample consists of spin-offs from higher education institutions. Questionnaires were mailed to 227 founders, from which a total of 149 usable

questionnaires were obtained. We performed a non-response analysis by comparing early versus late responses as well as responses versus non-responses. Tests indicated no statistically significant differences in the mean responses for the research variables assessed in this study. A non-response bias is therefore not likely to be an issue in interpreting the findings of the study.

Our sample of 149 academic spin-offs can be subdivided into three groups (Doutriaux, 1987), each representing one type of business activity: technical services (52%), consulting (31%), and technical manufacturing (17%). Technical service spin-offs are active in testing, research, and development. Consulting spin-offs advise and assist organizations on management, communication, and marketing issues, such as financial planning and budgeting, strategic and organizational planning, business process improvement, marketing, and production scheduling. The technical manufacturing spin-offs primarily operate in the diverse fields of computer equipment, electronic, and instruments.

The spin-offs possess their technological competencies in different technology fields, including management technologies (17%), information and communication technologies (16%), material and surface technologies (11%), electro-technologies (9%), life science technologies (9%), and energy and environment technologies (5%). The average age of the spin-offs was 8.3 years. The average number of staff was 16 people, which is comparable with other studies on university spin-offs (Jones-Evans et al., 1998; Pérez and Sánchez, 2003; Steffensen et al., 1999).

#### 4.2. Operationalization and measure validation

The scales employed in the present study were either developed specifically for this study or adapted from existing scales to suit this context. We started by developing an initial pool of scale items using in-depth interviews with founders of university spin-offs. All scales were pre-tested in four successive rounds. In each round, two to three interviewees were asked to complete the questionnaire. While completing the questionnaire, academic entrepreneurs verbalized any thoughts that came to mind. The items were revised following each interview round. At the end of round four, the feedback from the respondents indicated that the scale items were clear, meaningful, and relevant.

The measures were developed following guidelines set by Churchill (1992), and Gerbing and Anderson (1988). With the exception of two, all constructs were measured using seven point multiple-item scales. A complete listing of the scales used in the study is provided in Appendix A. We used traditional and advanced psychometric approaches to evaluate scale properties. Assessing their reliability and uni-dimensionality purified the proposed reflective measures. Measurement development followed procedures recommended by Anderson and Gerbing (1988). Item-to-total correlation was examined in each of the proposed scales and items with low correlation were deleted if they tapped no additional domain of interest. To help ensure uni-dimensionality, items in each multi-item scale were factor analyzed separately.

##### 4.2.1. Independent variables

Six items belong to EO, which is a reflective measure that captures the degree to which the spin-off exhibits entrepreneurial predisposition. The scale contains items that refer to

the key features of a firm's EO autonomy: proactiveness, innovation, risk taking, and assertiveness in business development (Dess et al., 1997; Miller, 1983). Three items are adapted from Dess et al. (1997). The other three items are based on the work of Lumpkin and Dess (1996). The mean score, calculated as the average of the six items, assesses a spin-off's intensity of entrepreneurial orientation. The coefficient alpha of the scale was 0.84. We also used a confirmatory factor analysis (CFA) technique (LISREL 8) (Jöreskog and Sörbom, 1996) to estimate the measurement model. The initial result of the analyses led to the elimination of one item from the measure. The generated goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and comparative fit index (CFI) (GFI=0.94, AGFI=0.87, CFI=0.97) indicate a good fit with the hypothesized measurement model (Bagozzi and Yi, 1988; Jöreskog and Sörbom, 1996). The Chi square statistic ( $\chi^2_{(9)}=26$ ,  $p=0.00$ ) was satisfactory, as the measure was 2.89 (Medsker et al., 1994). All the factor loadings are in acceptable ranges and significant at  $p=0.001$ , indicating convergent validity. The average variance extracted (AVE) by the entrepreneurial orientation measure of 0.49 is slightly under the recommended threshold of 0.50 suggested by Bagozzi and Yi (1988).

We conceptualized NC as a higher order construct that increases in magnitude as each of the four NC components increases, meaning that NC is a composite that requires a formative measure (Diamantopoulos and Winkelhofer, 2001). Coordination activities, relations skills, partner knowledge, and internal communication were viewed as integral parts of the NC construct. We created the NC index as a linear sum of the NC component means.

To measure the four components of NC, we adopted a reflective perspective to measurement. After the purification of items through multiple iterations of CFA (LISREL approach), we reduced the total number of items from 24 to 19. The six-item measure coordination activities ( $\alpha=0.87$ ) assesses synchronizing, planning, and controlling activities in both inter-organizational and inter-functional settings. The four-item measure of relational skills ( $\alpha=0.90$ ) appraises the extent to which employees in a spin-off are able to cultivate and shape close relationships. Partner specific knowledge was measured by four items ( $\alpha=0.86$ ) capturing the availability of information within a spin-off organization on network partners. Internal communication is a five-item measure ( $\alpha=0.85$ ) that reflects the communication quality and information dissemination in a spin-off organization. The average variance extracted was greater than 0.50 in all cases and greater than the squared structural link between the constructs. The inter-factor correlations ranged between 0.39 and 0.64 ( $p \leq 0.001$ ). Some items used to build the NC index were adapted from Mohr and Spekman (1994), and some were newly developed, reflecting crucial boundary-spanning tasks within an inter-functional context (e.g., Keller and Holland, 1975) and in inter-organizational settings (e.g., Dwyer et al., 1987, Ruekert and Walker, 1987).

In the next step, all reflective measures were analyzed for reliability and validity. CFA analysis was used to estimate a measurement model composed of the EO scale and the four NC scales. Using LISREL with the covariance matrix as input, each of the items loaded appropriately on one of the five first-order constructs. The standardized factor loadings ranged from 0.43 to 0.93. All first-order factor loadings were significant at  $p=0.001$ , indicating convergent validity. The average variance extracted ranged from 0.49 to 0.71. The maximum inter-factor correlation was 0.67. The global fit statistics ( $\chi^2_{(265)}=389$ ,

$p=0.00$ , GFI=84, AGFI=81, CFI=98, RMSEA=0.05) are acceptable. The CFI goes beyond the required value of 0.90. The GFI and AGFI values are greater than or at the minimum recommended value of 0.80. For the RMSEA, values of up to 0.08 are usually considered to indicate reasonable model fit (Browne and Cudeck, 1993).

To examine the discriminant validity of the five first-order constructs, we compared an unconstrained CFA model with one where the factor correlation was fixed to unity for all pairs of reflective measures (Bagozzi et al., 1991). In all cases, the unconstrained model produced a significantly superior fit. Discriminant validity between the three factors was also given, applying the criterion suggested by Fornell and Larcker (1981). All AVEs were greater than the squared structural links between the constructs.

Finally, in order to assess the suitability of the four NC components, an overall NC measurement item external to the NC index was correlated with the following variables: coordination activities, relational skills, market knowledge, and internal communication. An overall item that summarizes the essence of the formative construct was used as an external criterion (Diamantopoulos and Winklhofer, 2001). All four NC index variables turned out to be significantly correlated with the item “we develop mutual beneficial relationships with our partners.” The correlations (Pearson) ranged from 0.35 to 0.65 at  $p<0.001$ . Among the four NC variables, the correlations (max Pearson correlation=0.57), variance inflations factors (max VIF=1.78), and condition numbers (max CN=18.02) indicate that collinearity did not seem to pose a problem. Typically, correlations over 0.70, VIFs over 10, and CNs over 30 indicate serious multicollinearity problems.

#### 4.2.2. Spin-off performance

In order to investigate the impact of NC and EO on spin-off performance, it is important to recognize the multidimensional nature of the performance construct (Chakravarthy, 1986). The present study collected both objective and perceptual measures of firm performance. As recommended in the entrepreneurship literature (e.g., Covin and Slevin, 1991; Lumpkin and Dess, 1996), we considered growth in sales (sales growth rate) as a traditional accounting measure of firm performance. In this study, growth in sales is seen as an indication of the degree to which a spin-off's management was able to exploit its entrepreneurial autonomy. Additionally, growth in sales showed the market's acceptance of a spin-off's commercialized technologies and, therefore, is an indicator of technology transfer success. As a second performance measure, we used sales per employee as a measure that captures the efficiency of a knowledge-based organization where employees are the main assets.

Sapienza et al. (1988, p. 46) note that “many owners/entrepreneurs for a variety of reasons report manipulated performance outcomes.” Therefore, we gathered information (actual sales, number of employees) regarding the objective performance measures by phone directly from the spin-offs' accounting offices after we received a completed questionnaire. Growth in sales was calculated by averaging the scores of the two past business periods. Sales per employee ratios were averaged over the three past business periods. For both measures, we calculated the logarithm. It was not possible to gather financial performance measures, such as ROI or ROA, which are used intensively as financial performance indicators in strategic management research, as the financial data on

the sampled spin-offs was not publicly available. Moreover, our pre-test revealed that the respondents were very reluctant to give the figures, as is often the case in small firm research (e.g., Covin and Slevin, 1990).

Incorporating a firm's objectives and aspiration levels into measurements of firm performance is considered useful (e.g., Kirchhoff, 1977; Naman and Slevin, 1993), as the sales growth rate and sales per employee fail to indicate the degree of congruence between intended goals and performance. Thus, in addition to these objective performance measures, we chose four perceptual subjective measures: profit attainment, perceived customer relationship quality, realized competitive advantages, and securing long-term survival.

The spin-off's profit attainment was measured with a single item indicating whether the spin-off has achieved its respective growth objective on a 7-point scale. The remaining three measures are non-financial objectives. Firms may regard non-financial goals, like continued existence, public image, customer satisfaction, and customer retention, as indicators of high performance, even though they cannot claim growth and cost advantages (Lumpkin and Dess, 1996; Zahra, 1993b). Zahra (1993a) has noted that the importance of financial and non-financial performance measures change at different points in the life cycle of new ventures.

Relationship quality is a higher order construct often encompassing three distinct, although related dimensions of business relationships: trust, satisfaction, and commitment (Crosby et al., 1990). Perceived customer relationship quality (CRQ) was measured by obtaining individual responses to the achievement of three customer objectives on a 7-point scale: customer satisfaction, customer trust, and customer retention ( $\alpha=0.81$ ; AVE=0.63). A spin-off's realized competitive advantages were measured with three items indicating the extent to which a spin-off has gained advantages in its generation of know-how, customization of technologies, and cost savings on a 7-point scale ( $\alpha=0.74$ ; AVE=0.55). Finally, we considered a spin-off's securing of long-term survival as a non-financial performance measure (one item). Discriminant validity between the four subjective performance measures (profit attainment, perceived CRQ, realized competitive advantages, long-term survival) was given applying the criterion suggested by Fornell and Larcker (1981).

#### *4.2.3. Control variables*

The commercialization of scientific and technological knowledge takes time, and the development of an organization and its business relationships is a time-consuming process. Roberts (1990) shows that spin-off companies are likely to change their business priorities over time. For example, established spin-offs may have decided not to grow over a certain size. Therefore, we controlled for the age of a spin-off (logarithm). As large organizations have more resources to conduct R&D and have more power to shape their business relationships, we also considered the size of the spin-off organization as a control variable and measured it as the log of total employees. Finally, we tested for effects of the industry and technology fields in which the spin-offs were operating. These variables were coded as dummy variables and control the impact of such differences in industry and technology fields as competition, regulations, maturity of technology, and technology dynamic. In his longitudinal study of academic spin-offs, Droutriaux (1987) found that the growth behavior

of service firms is very different from the behavior of manufacturing firms. Fewer opportunities for commercialization may exist in some technology fields than in others.

#### 4.3. Results

The means, standard deviations, and bivariate correlations for all variables are presented in Table 1. Moderated regression analysis was used to test the hypotheses, as suggested by Aiken and West (1991) and Jaccard et al. (1991). In each regression, the control variables (spin-off age and spin-off size) and dummy variables representing each spin-off's industry and technology field were entered in step 1. The independent variables (NC and EO) were included in step 2, followed by the interaction term of NC and EO in step 3. To reduce possible problems with multi-collinearity resulting from interaction terms, we centered the independent predictor variables prior to computing the interaction term. The correlations among the predictor variables, variance inflations factors (max VIF=6.06), and condition numbers (max CN=19.75) indicate that collinearity is not unduly influencing the estimates of regression coefficients.

In a main effects model, the regression coefficients estimate general relationships across all observed levels of the other predictors. Consistent with Hypothesis 1, NC has a positive effect on sales growth ( $b=0.02, p \leq 0.10$ ), sales per employee ( $b=0.02, p \leq 0.05$ ), profit attainment ( $b=0.10, p \leq 0.01$ ), perceived CRQ ( $b=0.17, p \leq 0.05$ ), realized competitive advantages ( $b=0.05, p \leq 0.01$ ), and long-term survival ( $b=0.16, p \leq 0.001$ ). Hypothesis 2 was only partially supported. EO has a significant effect on perceived CRQ ( $b=0.11, p \leq 0.10$ ), and realized competitive advantages ( $b=0.28, p \leq 0.01$ ). However, the effects of EO on sales growth, sales per employee, profit attainment, and securing long-term survival were not significant in model 2.

Table 2 presents the results of the overall interaction models (model 3). The  $R^2$ , ranging from 0.29 to 0.40, indicate a satisfactory level of explanation of the performance variables. Differences in the values of coefficients for the main effects model and the overall interaction model result from the fact that the NC and EO coefficients in the latter model estimate conditional relationships (Aiken and West, 1991; Jaccard et al., 1991).

Table 1  
Descriptive statistics and correlations\*

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1. Network capabilities	19.88	3.57	1.0									
2. Entrepreneurial orientation	5.17	0.94	0.64	1.0								
3. Growth in sales	0.07	0.51	0.12	0.11	1.0							
4. Sales per employee	4.27	0.45	0.32	0.25	+0.04	1.0						
5. Profit attainment	4.52	1.61	0.33	0.27	0.15	0.15	1.0					
6. Perceived customer relationship quality	5.87	0.78	0.41	0.34	-0.10	0.38	0.37	1.0				
7. Realized competitive advantages	4.88	1.01	0.42	0.43	0.08	0.35	0.34	0.45	1.0			
8. Securing long-term survival	5.32	1.29	0.49	0.31	0.07	0.22	0.40	0.42	0.37	1.0		
9. Spin-off size	1.01	0.37	0.43	0.37	0.10	0.27	0.28	0.36	0.32	0.35	1.0	
10. Spin-off age	0.79	0.36	0.03	-0.01	-0.37	0.19	-0.13	0.11	0.07	0.16	0.37	1.0

\* Correlations greater than 0.15 (.11) are significant at  $p \leq 0.05$  (0.10) (one-tailed).

Table 2  
Regression results (unstandardized coefficients)

Independent variable	Sales growth	Sales per employee	Profit attainment	Perceived customer relationship quality	Realized competitive advantages	Securing long-term survival
Constant	0.57 <sup>†</sup>	4.03***	4.27***	5.31***	4.32***	4.63***
Main effects:						
Network capabilities	0.03*	0.03*	0.12**	0.04*	0.07**	0.18***
Entrepreneurial orientation	0.03	0.08 <sup>†</sup>	0.25 <sup>†</sup>	0.12 <sup>†</sup>	0.36**	0.04
Interaction effect:						
Network competence × entrepreneurial orientation	0.02*	0.02*	0.04*	0.01	0.04**	0.04*
Control variables: <sup>a</sup>						
Spin-off age	−1.03***	0.31*	−0.89*	0.20	0.07	0.40
Spin-off size	0.17	0.11	0.83*	0.55**	0.20	0.36
Industry field dummies	3 Dummies	3 Dummies	3 Dummies	3 Dummies	3 Dummies	3 Dummies
Technology field dummies	15 Dummies	15 Dummies	15 Dummies	15 Dummies	15 Dummies	15 Dummies
R <sup>2</sup> (adjusted R <sup>2</sup> )	0.35 (0.23)	0.34 (0.21)	0.40 (0.30)	0.29 (0.17)	0.32 (0.21)	0.36 (0.26)
ΔR <sup>2</sup> step three	0.03*	0.02*	0.01 <sup>†</sup>	0.00	0.03**	0.02 <sup>†</sup>
F	2.80***	2.63***	4.04***	2.45***	2.88***	3.42***
N	130 <sup>b</sup>	130 <sup>b</sup>	149	149	149	149

\*\*\*p≤0.001; \*\*p≤0.01; \*p≤0.05; <sup>†</sup>p≤0.10 (one-tailed test of coefficients).

<sup>a</sup> Industry and technology field dummies not reported.

<sup>b</sup> Spin-offs existing for 3 or more years.

The NC × EO interaction terms are, with one exception, all positive and significant (on sales growth:  $b=0.02$ ,  $p\leq 0.05$ ; on sales per employee:  $b=0.02$ ,  $p\leq 0.05$ ; on profit attainment:  $b=0.04$ ,  $p\leq 0.05$ ; on realized competitive advantages:  $b=0.04$ ,  $p\leq 0.01$ ; on securing long-term survival:  $b=0.04$ ,  $p\leq 0.05$ ). The  $\Delta R^2$  for the contingency versus main effects models are statistically significant. Thus, Hypothesis 3 is supported with respect to most of our performance measures. The interaction effect of NC × EO on perceived CRQ was, as expected, positive, but not significant.

Table 3  
Results of simple slope analysis (unstandardized coefficients)

	Slope for various levels of the moderator variable <sup>a</sup>		
	Low (M − SD)	Moderate (M)	High (M + SD)
Entrepreneurial orientation→Sales growth	−0.04	0.03	0.10
Entrepreneurial orientation→Sales per employee	0.02	0.08	0.14
Entrepreneurial orientation→Profit attainment	0.11	0.25	0.40
Entrepreneurial orientation→Realized competitive advantages	0.21	0.36	0.50
Entrepreneurial orientation→Securing long-term survival	−0.09	0.04	0.18

<sup>a</sup> Network capability.

To gain support for the direction of the hypothesized interaction relationships and to examine the consistency of that direction throughout the range of NC, we conducted simple slope analyses (Aiken and West, 1991). Table 3 depicts that the slopes of EO remained positive over the entire range of NC regarding the models with sales per employee and realized competitive advantages as dependent variables. However, the slopes were significantly more positive at high levels of EO than at low levels. For the models with sales growth and profit attainment as dependent variables, the slope analyses revealed a slightly negative slope of EO at low levels of NC and a positive slope at high levels of NC. Thus, NC strengthens the positive effects of EO on a spin-off's sales growth, sales per employee, profit attainment, realized competitive advantages, and long-term survival.

## 5. Discussion

This study examines how NC and EO affect the organizational performance of university spin-offs. NC is the organization's ability to develop, use, and maintain relationships with external partners, including customers, suppliers, and research institutions. A spin-off's EO refers to self-direction in pursuing opportunities, proactivity in attaining competitive advantages, risk taking in projects, innovativeness in developing products and services, and assertiveness in promoting the spin-off.

### 5.1. NC and spin-off performance

Our study shows that the performance variables (growth in sales, sales per employee, profit attainment, perceived CRQ, realized competitive advantages, and long-term survival) are influenced by a spin-off's NC. The results confirm prior studies on alliance competence showing that firms vary considerably in their capabilities to gain access to external resources and to develop stable relationships (Dyer and Singh, 1998). These variations lead to differences in organizational performance.

The results of this research offer two theoretical contributions. First, they support the recent arguments of entrepreneurship scholars regarding the importance of networks for spin-off success (Hoang and Antoncic, 2003). Second, as we have analyzed the ability of networking and not only the existence of a network, we contribute with an insight motivated from the capability-based view of the firm, highlighting that university spin-offs perform better as their network capability increases.

### 5.2. EO and spin-off performance

In the present study, EO was not found to have a direct effect on sales growth, sales per employee, or profit attainment. This confirms the results of Covin and Slevin (1988, 1990) and Dess et al. (1997), suggesting that EO does not always lead to growth and profitability. We can conclude that the existence of EO per se does not promote financial growth and long-term survival of a spin-off. These results support the general notion that the EO–performance relationship depends on

the context in which it occurs. For these reasons, “entrepreneurial activities should not be regarded as panacea for improving organizational performance” (Covin and Slevin, 1988, p. 229).

However, we found that EO has a highly significant direct effect on the realization of competitive advantages. Obviously, university spin-offs may use EO as an effective means to strive for competitive advantages. The moderately significant effect of EO on the perceived CRQ signals that EO can preserve a spin-off’s existence, attract customers, and improve the organization’s reputation as a competent technology provider. As such, EO contributes to the relational capital (Kale et al., 2000) of the firms, which may be seen as an investment in a market position. These findings support the notion of Zahra (1993b) that, in addition to growth and profitability, entrepreneurial behavior may produce worthwhile, non-financial contributions or by-products.

### *5.3. Moderating effect of NC on the EO–performance relationship*

Pursuing an EO is a resource-consuming process (Dess et al., 1997). Covin and Slevin (1991) have argued that an organization’s entrepreneurial capacity will be limited by its available resources and capabilities. In the present study, the moderating role of NC is shown. Comparing the reduced model to the full model and its associated interaction term clearly reveals that NC moderates the relationship between EO and spin-off performance. We found that the two variables have a significant interaction effect on growth in sales, sales per employee, profit attainment, realized competitive advantages, and securing long-term survival. Thus, NC strengthens the relationship between EO and spin-off performance. For example, academic spin-offs with access to the scientific knowledge of other research institutions, and information on customer needs and preferences may possess better preconditions to develop and launch new products and services successfully. Our findings support the general notion that entrepreneurial ambitions should be based on capabilities that advance opportunity seeking and accelerate the introduction of new products and services (Covin and Slevin, 1991).

Due to their small size, weak market recognition, lack of reputation, and the innovativeness of their products, spin-offs are dependent on the development of good working relationships while aggressively entering new markets and trying to identify customer needs to which they can apply their technologies. Access to (initial) customers is particularly important and, as such, spin-offs may build relationships with partners that commercialize their technologies. Such a strategy may hasten adaptation and, thereby, create a higher innovation rent, even though the gains need to be shared between the partners. Direct interactions with customers are not only beneficial for spin-offs. Customers that gain access to and an understanding of state-of-the-art technology may use this advantage for their own competitive situation in their markets.

These results have important implications for the management of university spin-offs. Firms should note that an entrepreneurial orientation in and of itself is not enough to compete in today’s markets. EO is an entrance ticket that allows for higher impacts of competencies on performance. However, entrepreneurial ambitions alone do

not create value and should not be seen as the fundamental force for the sustainable prosperity and growth of spin-offs. This also means that the demand for more entrepreneurial academics expressed by politicians should be revisited and potentially enriched. Our findings suggest that successful university spin-offs are not only entrepreneurial but also continually networking.

We suggest that firms develop their network capability and their networks as a means to improve performance. One possibility is to work with experienced and well-known business people. Some governmental agencies and venture capitalists run mentor programs that aim to develop networks. Another issue is to make resources for networking available and to empower and encourage persons to develop relationships with external partners. Without the whole-hearted commitment of a person carrying out relationship management responsibilities (Clarysse and Moray, 2004), a stable network of crucial venture partners is unlikely to occur. Universities which want to promote spin-offs should also think of ways to support networking for their academics. Networks are of catalytic importance in the creation of university spinouts (Nicolaou and Birley, 2003b).

Our results may also be informative for firms other than spin-offs. First, venture capitalists and other investors can be advised to analyze not only the technological capabilities and entrepreneurial orientation of spin-offs, but also their network capability before making an investment decision. As our results show, network capability has a key influence on a wide variety of performance measures and, as such, should be more seriously considered. Second, despite the specific characteristics of university spin-offs (as referred to in the Introduction), these spin-offs have some similarity with other high-tech spin-offs, such as spin-offs from large firms. These spin-offs are normally also technology driven, small, have a high business risk, and aim to produce innovative products. These results may be applicable for these firms, although an empirical test of this proposition could be an interesting topic for further research. Third, firms working with university spin-offs should look for spin-offs with a high network capability, not only in order to establish a better relationship between a given partner and the spin-off, but also to better predict the long-term survival of the spin-off. For the partner, the development of a relationship with a spin-off becomes a sunk cost when the spin-off goes out of business. As such, it is in the best interest of the partner to find business opportunities with a high likelihood of success, i.e., a university spin-off with high entrepreneurial orientation and network capability.

#### 5.4. Limitations

Although the study provides some interesting findings, several limitations should be noted. Previous investigations paid attention to the variables of relationships strategy and entrepreneurship, structure and entrepreneurship, and environment and entrepreneurship, or to more complex configurations of these variables (e.g., Covin and Slevin, 1988, 1990; Dess et al., 1997; Naman and Slevin, 1993; Zahra, 1993a). An examination of how strategy, structure, or environment moderates the EO–performance relationship of spin-offs would be useful, as would an examination of the NC–

performance relationship in different environments. These aspects are not addressed by the present study.

Our study used a single key informant approach, which is a common practice in entrepreneurial research. Kumar et al. (1993) have suggested that choosing the appropriate key informant could alleviate some of the potential problems. We have chosen the academic founders of spin-offs as key informants, people we assume are well informed about their own organization. However, the debate on whether multiple responses from an organization are necessary to ensure the validity of results, such as those of this study, continues (Phillips, 1981). Nevertheless, the use of multiple informants (e.g., Dess et al., 1997; Zahra, 1993a) is a more rigorous data collection procedure. To some extent, we have minimized the common source bias by collecting accounting data from a second person. As the results of that measure are not significantly different from our other measures, we assume that common source bias is not a major issue in this study.

Our cross-sectional data do not allow causal inferences about the longitudinal interplay between EO, NC, and spin-off performance. EO and NC were considered as antecedents of firm performance. However, the opposite relationships cannot be dismissed, as the interplay between these variables is dynamic in nature. For example, gaining financial revenues and building customer trust and satisfaction may enable companies to enhance their organizational learning and flexibility.

### *5.5. Further research questions*

University spin-offs have a unique set of parameters, including the fact that they are often technology driven and may involve part-time business people. Despite the fact that our results are limited to that area, the presented empirical data also inform our general understanding of spin-off success. As indicated in the Introduction, empirical results on the entrepreneurial orientation–performance relationship have produced contradicting evidence. In this paper, we offer a potential explanation which could be further evaluated with other spin-offs. Other moderating effects, such as market and technology dynamics, may also be interesting subjects of investigation.

Additional avenues for further research based on the present results include the development process of NC. The establishment of NC as early as possible in the spin-off's development seems important in terms of enabling performance. Are there measures which can ensure this capability even before the spin-off is established? How can NC be built up quickly after foundation? The interplay between EO and NC should also be analyzed. While EO may foster NC through an acceptance of risk and a commitment to innovation, the opposite is also possible. NC and inputs from the network may trigger EO by providing information on market opportunities and demands for innovations. In the future, we might see more and more entrepreneurial networks of firms, where the firms along the value chain challenge themselves for further innovation. Spin-offs could be particularly vital for inspiring such networks, while also obtaining ideas and support from their partners for innovative products.

## Appendix A

### 4.1. Organizational performance

Sales<sub>t,0</sub> (latest business period):

Sales<sub>t-1</sub> (1 year ago):

Sales<sub>t-2</sub> (2 years ago):

Sales growth: lg10 ((sales<sub>t-1</sub>/sales<sub>t-2</sub>+sales<sub>t,0</sub>/sales<sub>t-1</sub>)/2).

Total number of employees<sub>t,0</sub>:

Total number of employees<sub>t-1</sub>:

Total number of employees<sub>t-2</sub>:

Sales per employee: lg10 ((sales<sub>t,0</sub>/employees<sub>t,0</sub>+sales<sub>t-1</sub>/employee<sub>t-1</sub>+sales<sub>t-2</sub>/employee<sub>t-2</sub>)/3).

To which extent are the following objectives of your organization actually being achieved? (1—goal not achieved at all, 7—goal is completely achieved).

*Profit attainment:*

Increase in profit.

*Perceived customer relationship quality:*

Customer satisfaction.

Customer trust.

Customer retention.

*Realized competitive advantages:*

Advantages in the customization of performance over our competitors.

Advantages in the creation of know-how.

Cost advantages over our competitors.

*Securing of long-term survival:*

Long-term survival of our organization.

### 4.2. Network capability

To what extent do the following statements apply to your organization regarding the form, care of and use of relationships to partners (customers, suppliers, technology partners, “multipliers”)? (1—statement does not apply at all, 7—statement applies completely)

*Coordination:*

We analyze what we would like and desire to achieve with which partner.

We match the use of resources (e.g., personnel, finances) to the individual relationship.

We inform ourselves of our partners’ goals, potentials and strategies.

We judge in advance which possible partners to talk to about building up relationships.

We appoint coordinators who are responsible for the relationships with our partners.

We discuss regularly with our partners how we can support each other in our success.

*Relational skills:*

- We have the ability to build good personal relationships with business partners.
- We can put ourselves in our partners' position.
- We can deal flexibly with our partners.
- We almost always solve problems constructively with our partners.

*Partner knowledge:*

- We know our partners' markets.
- We know our partners' products/procedures/services.
- We know our partners' strengths and weaknesses.
- We know our competitors' potentials and strategies.

*Internal communication:*

- In our organization, we have regular meetings for every project.
- In our organization, employees develop informal contacts among themselves.
- In our organization, communication is often across projects and subject areas.
- In our organization, managers and employees do give intensive feedback on each other.
- In our organization, information is often spontaneously exchanged.

*A.3. Entrepreneurial orientation*

To what extent do the following statements apply to your organization's style? (1—statement does not apply at all, 7—statement applies completely).

- In this organization, entrepreneurial behavior is a central principle.
- In this organization, people are very dynamic.
- In this organization, innovation is emphasized above all.
- In this organization, people are willing to take risks.
- In this organization, willingness to continuous progress is the joint foundation.
- In this organization, people are eager at being always first to market.

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