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SOCIAL CAPITAL, KNOWLEDGE ACQUISITION, AND KNOWLEDGE EXPLOITATION IN YOUNG TECHNOLOGY-BASED FIRMS

HELENA YLI-RENKO[1]*, ERKKO AUTIO[2] and HARRY J. SAPIENZA[3]
[1]*London Business School, London, U.K. and McKinsey & Company, Los Angeles, California, U.S.A.*
[2]*Helsinki University of Technology, Espoo, Finland*
[3]*Carlson School of Management, University of Minnesota, Minneapolis, Minnesota, U.S.A.*

Employing a sample of 180 entrepreneurial high-technology ventures based in the United Kingdom, we examine the effects of social capital in key customer relationships on knowledge acquisition and knowledge exploitation. Building on the relational view and on social capital and knowledge-based theories, we propose that social capital facilitates external knowledge acquisition in key customer relationships and that such knowledge mediates the relationship between social capital and knowledge exploitation for competitive advantage. Our results indicate that the social interaction and network ties dimensions of social capital are indeed associated with greater knowledge acquisition, but that the relationship quality dimension is negatively associated with knowledge acquisition. Knowledge acquisition is, in turn, positively associated with knowledge exploitation for competitive advantage through new product development, technological distinctiveness, and sales cost efficiency. Further, our results provide evidence that knowledge acquisition plays a mediating role between social capital and knowledge exploitation.

INTRODUCTION

As an extension of the resource-based view, the relational view maintains that competitive advantage derives not solely from firm-level resources but also from difficult-to-imitate capabilities embedded in dyadic and network relationships (Dyer and Singh, 1998; Lane and Lubatkin, 1998). By building relation-specific assets, knowledge-sharing routines, and effective relational governance mechanisms into relationships, firms can leverage their relational resources for knowledge acquisition and exploitation. Given that resource limitations of younger firms make them prone to liabilities of newness and adolescence (Amburgey, Kelly, and Barnett, 1993; Stinchcombe, 1965), this perspective helps to explain how and why some entrepreneurial firms are able to survive, thrive, and grow despite the lack of significant firm-specific resources.

Another extension of the resource-based view concerns knowledge as a source of sustainable competitive advantage, as advocated in the knowledge- and learning-based views of the firm (Kogut and Zander, 1992; Grant, 1996; Spender, 1996). Knowledge is particularly important for technology-based firms: generating and exploiting knowledge in high-technology sectors demands that knowledge be continually replenished (Lane and Lubatkin, 1998). Because the acquisition and exploitation of knowledge are predominantly social processes (Kogut and Zander, 1992), social capital may be critical for the long-term success of technology-based firms.

In this paper, we extend the above literatures by exploring how young technology-based firms can leverage interorganizational relationships to acquire external knowledge and exploit it for competitive advantage. We argue that the degree

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*Correspondence to: Helena Yli-Renko, McKinsey & Company, 400 South Hope Street, Los Angeles, CA 90071, U.S.A.

to which firms can use external relationships for knowledge acquisition and exploitation is regulated by the amount of social capital embedded in such relationships. Social capital in a relationship enables the firm to tap into the knowledge resources of its exchange partner. Through close social interaction, firms are able to increase the depth, breadth, and efficiency of mutual knowledge exchanges (Lane and Lubatkin, 1998).

The focus of this paper is on the exchange relationship between the young firm and its single largest customer, the one that accounts for the highest proportion of sales revenue. We refer to this partner as the 'key customer.' Our model argues that aspects of social capital (social interaction, relationship quality, and network ties) embedded in relationships of young technology-based firms with key customers increase the young firms' knowledge acquisition from these relationships, and that knowledge acquisition may then be exploited for competitive advantage through new product creation, enhanced technological distinctiveness, and reduced sales costs. We test the model with mail survey data from 180 young technology-based firms in the United Kingdom.

Our study makes several contributions to the literature. First, prior work has typically studied firms' access to tangible external resources, such as manufacturing capacity and distribution channels (Lorenzoni and Ornati, 1988; Shepherd, 1991), whereas we focus on knowledge acquisition from interorganizational relationships as a source of competitive advantage. Second, we extend developments in social capital theory and the relational view into interfirm relationships of young firms with their key customers. Third, we validate operationalizations of difficult-to-measure constructs critical to the examination of these theories (Spender and Grant, 1996). Fourth, we examine both knowledge acquisition and knowledge exploitation, whereas most prior studies examine one only (Lane and Lubatkin, 1998). Finally, while earlier work on firm networking has often focused on a single outcome, such as sales growth (McGee and Dowling, 1994) or innovation (Shan, Walker, and Kogut, 1994), we examine three knowledge exploitation outcomes, including new product development, technological distinctiveness, and sales cost efficiency.

This study links elements of strategy and entrepreneurship. The resource- and knowledge-based views of the firm have prompted strategy researchers to focus on value creation, as opposed to value appropriation (Conner, 1991; Kogut and Zander, 1996; Nahapiet and Ghoshal, 1998). Strategy research has begun to approach the domain of entrepreneurship research, where the focus has long been on value creation through 'new combinations' (Schumpeter, 1934), or 'where several different resources have to be brought together to create the new product or service' (Shane and Venkataraman, 2000: 220). Thus, strategy and entrepreneurship researchers share an interest in resource acquisition, sharing, and exploitation for the purpose of value creation. Of the various resources available to the firm, knowledge is arguably the most important (Spender, 1996). By highlighting the important links between social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms, we seek to contribute to a further convergence between the domains of strategy and entrepreneurship research.

THEORETICAL FRAMEWORK AND HYPOTHESES

This paper builds on the knowledge-based view of the firm, which depicts firms as repositories of knowledge and competencies (Kogut and Zander, 1996; Spender, 1996). According to this view, the 'organizational advantage' (Ghoshal and Moran, 1996) of firms over markets arises from their superior capability in creating and transferring knowledge. Knowledge creation and innovation result from new combinations of knowledge and other resources (Cohen and Levinthal, 1990; Kogut and Zander, 1992). The accumulation of knowledge through learning constitutes a driving force in the development and growth of young firms (Penrose, 1959; Spender and Grant, 1996), because knowledge acquisition opens new 'productive opportunities' (Penrose, 1959) and enhances the firm's ability to exploit these opportunities. The development and growth of young technology-based firms are particularly dependent upon innovatively combining their own firm-specific knowledge with that of external partners because young firms are resource constrained (McDougall, Shane, and Oviatt, 1994) and because young technology-based firms depend upon knowledge rejuvenation to survive and grow (Autio, Sapienza, and Almeida, 2000).

The type of knowledge involved affects knowledge acquisition and exploitation (Lane and Lubatkin, 1998). We focus on external knowledge acquired through the social capital embedded in the firm–key customer relationship. Like Lane and Lubatkin (1998), we focus on the firm level, rather than the individual level. In regard to knowledge content, our focus is on what Eriksson *et al.* (1997) termed external 'business' knowledge, i.e., knowledge of products, markets, and technology, rather than 'organizing' knowledge, i.e., knowledge of structures and systems; external business knowledge includes both explicit and tacit components. Whereas Lane and Lubatkin (1998) showed that a firm's capacity to recognize, assimilate, and exploit external knowledge depends in part on the similarity between the exchange partners' knowledge bases, organization systems, and dominant logics, we focus on the role of social capital in facilitating external business knowledge acquisition and exploitation. Also, while we recognize that different firms possess differing capacity for knowledge exploitation, or 'differential transformative capacities' (Garud and Nayyar, 1994), beyond those depending on social capital, our focus is not explicitly on the knowledge exploitation process but rather on its results.

Organizational learning and interorganizational relationships

Numerous frameworks of organizational learning have been proposed in organization literature. Many of these conceptualize learning as a process of knowledge acquisition, knowledge assimilation, and knowledge exploitation (Argote, 1999; Cohen and Levinthal, 1990; Huber, 1991). In this study, we follow Huber (1991: 89) in assuming that 'an organization learns if any of its units acquires knowledge that it recognizes as potentially useful to the organization.' Further, we argue that young firms may develop social capital as a strategy to aid in acquiring new knowledge. A competitive advantage results when a firm implements strategy that creates value which other companies cannot efficiently replicate (Hitt, Ireland, and Hoskisson, 1999: 5).

Recent studies have proposed that interorganizational relationships create opportunities for knowledge acquisition and exploitation (Dyer and Singh, 1998; Lane and Lubatkin, 1998; Larsson *et al.*, 1998). Through interactions with others, firms get access to external knowledge and can combine it with existing knowledge. Further, such relationships create a context within which newly created knowledge can be applied and exploited. Several studies have examined how firms pursue learning opportunities in interorganizational settings, e.g., buyer–seller relationships (von Hippel, 1988) and supplier and customer relationships of entrepreneurial firms (Larson, 1992) and small firms (Uzzi, 1997). Yet, few studies have examined the role of social capital in facilitating learning in interorganizational relationships.

Interorganizational relationships include those a firm may have with external organizations including customers, suppliers, investors, government institutions, and the like (Dyer and Singh, 1998; Larson, 1992). We focus on a very important relationship for a young firm: that with its major customer. Our premise is that the more social capital a young technology-based firm develops in the relationship, the more likely it is to acquire new knowledge and exploit it as a basis of competitive advantage. Our logic maps closely onto Dyer and Singh's (1998) model of relational rents which proposes that the potential a firm has to create competitive advantage depends not just on its own resources but also on its relationships with other key firms.

Social capital and knowledge acquisition in key customer relationships

The extent to which a young technology-based firm acquires external knowledge from its key customer depends on the existence of external knowledge, on the ability of the firm to recognize and assess the value of the knowledge, on repeated, intense interaction, and on the willingness of the firms to share information (Cohen and Levinthal, 1990; Dyer and Singh, 1998). We follow Nahapiet and Ghoshal (1998) in arguing that social capital facilitates knowledge acquisition and exploitation by affecting conditions necessary for the creation of value through the exchange and combination of existing intellectual resources. Central to the argument is that social capital influences the knowledge available for the focal operator through her network of relationships (a 'structural component,' operationalized in this paper as customer network ties); the knowledge actually disclosed to, or retrieved by,

the focal operator (a 'relational component,' operationalized in this paper as social interaction); and the efficiency of the resulting knowledge transfers and exchanges (a 'cognitive component,' operationalized in this paper as relationship quality). Lane and Lubatkin (1998) pointed out that dyadic learning relationships involve a pattern of interactions that affect the learning of both members of the dyad; however, this learning is not necessarily symmetrical, since the member-specific learning outcome will be determined by the differing assimilation efforts and ability of each member of the dyad (Inkpen, 2000). We focus our analysis on an exposition of the knowledge effects on just the young technology-based firm.

The concept of social capital was originally used in community studies to describe relational resources embedded in personal ties in the community (Jacobs, 1965). The concept has since been applied in a wide range of intra- and inter-organization studies (Burt, 1992; Nahapiet and Ghoshal, 1998). Consistent with a relational view of competitive advantage (Dyer and Singh, 1998; Hitt *et al.*, 2000), our focus is on how social capital in a young firm's relationship with its key customer affects the firm's ability to acquire new knowledge and exploit it for product development, technological distinctiveness, and reduced sales costs.

We contend that the amount of external knowledge a young firm will obtain from the key customer depends on three aspects of social capital in the relationship: the level of social interaction between the firms, the quality of the relationship in terms of goodwill trust and reciprocity, and the level of network ties created through the relationship. *Social interaction* refers to the extent of social relationships between the focal firm and the customer (Nahapiet and Ghoshal, 1998; Larson, 1992; Ring and Van de Ven, 1994). *Relationship quality* refers to the extent that this interaction is marked by the development of goodwill trust and expectations of reciprocity (Dyer and Singh, 1998; Larson, 1992; Ring and Van de Ven, 1994). *Customer network ties* denote the extent to which the key customer provides the focal firm access or introductions to a broader set of customers (McEvily and Zaheer, 1999; Uzzi, 1997). We also expect that knowledge acquisition will enhance knowledge exploitation processes, by speeding up new product development, enhancing technological distinctiveness, and reducing sales costs. Our full model is shown in Figure 1.

Social interaction and knowledge acquisition

Greater levels of social interaction between a young technology-based firm and its key customer increase the knowledge the young firm acquires through that relationship by intensifying role interactions (Ring and Van de Ven, 1994), by enhancing the firm's ability to recognize and evaluate pertinent knowledge (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998), and by thence increasing its incentive to exchange and process information (Dyer and Singh, 1998; Larson, 1992; Zahra, Ireland, and Hitt, 2000).

Larson (1992) and Ring and Van de Ven (1994) note that social interactions develop over time in dyadic relationships as exchange partners become comfortable with each other's competence and reliability in economic exchange. In turn, the more these social interactions build, the greater the intensity, frequency, and breadth of information exchanged. For example, talking over customers' requirements for the next fiscal year in a local pub may lead to understanding of customer needs not usually exchanged in the ordinary course of business. Indeed, Larson (1992) observed that the greater the social interaction an entrepreneurial firm had with an exchange partner, the more intense the business-related exchange of information. Lane and Lubatkin (1998) argued that while observable or explicit knowledge may be relatively easy to obtain through passive efforts such as reading trade journals or more active methods such as benchmarking, interactive learning allows a firm to get close enough to acquire not just the observable, but the deeper tacit components of knowledge (Kogut and Zander, 1996).

Not only should social interaction facilitate knowledge acquisition by creating intense, repeated interaction, it should also enhance the young firm's ability to recognize and evaluate the pertinent external knowledge of the key customer. Greater social interaction provides the technology-based firm insight on the specialized systems and structures of the key customer and results in specialized information, language, and know-how (Dyer and Singh, 1998; Lane and Lubatkin, 1998). In essence, social interaction provides bet-

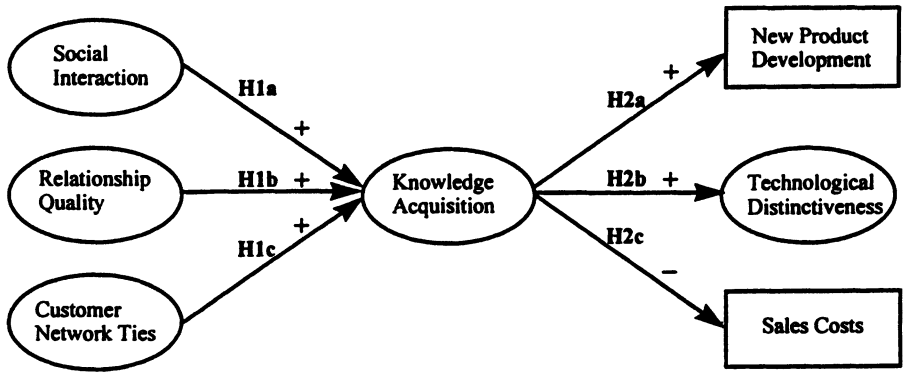

Figure 1. Hypothesized model. This is a simplified version of the actual model. It does not show error terms, control variables, or the indicator variables of the latent constructs. Latent variables are represented by ovals; observed variables are represented by rectangles

ter access to and understanding of the key customer's operations and more effective means of communicating with the key customer.

By intensifying the frequency, breadth, and depth of information exchange, social interaction increases relation-specific common knowledge. Common knowledge, in turn, increases relation-specific absorptive capacity because the ability of a firm to take on new knowledge is dependent on its possession of prior, related knowledge (Cohen and Levinthal, 1990). Thus, because the ability of each dyad member to absorb the communicated knowledge is enhanced through repeated social interaction, both parties have a relatively greater incentive to invest even more in knowledge-sharing routines. By intensifying knowledge-sharing activities, social interaction serves to increase the relative capacity and effectiveness of a young technology-based firm in recognizing and absorbing external knowledge from the key customer. Thus, we hypothesize:

> *Hypothesis 1a: The greater the social interaction between a key customer and a young technology-based firm, the greater will be the young technology-based firm's knowledge acquisition from that relationship.*

Relationship quality and knowledge acquisition

The quality of a relationship between a young firm and its key customer is reflected in the extent to which the two parties develop common goals, norms, and reciprocal expectations regarding the goodwill trustworthiness of the exchange partner (Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). Goodwill trust and reciprocal obligations have often been seen as alternatives or complements to formal, arm's-length, or third-party governance mechanisms (Dyer and Singh, 1998; Larson, 1992).

Dyer and Singh (1998) argue that because the costs of sharing know-how in interorganizational relationships are high, effective mechanisms must be in place to allow knowledge sharing and discourage free-riding. In their framework, self-enforcing governance mechanisms, such as informal norms of reciprocity and trust, are effective at promoting knowledge sharing and discouraging free-riding because (1) relational governance norms are not time-dependent (i.e., have no clear end point and may appreciate in value as the relationship progresses), (2) actions are more freely undertaken on behalf of the exchange partner when reciprocal benefits are expected, and (3) the likelihood of violation is diminished when high-quality, hard-to-replace relationships exist. Larson's (1992) study of entrepreneurial firms' relations with customers and suppliers shows that norms of reciprocity allow firms the control and freedom needed to exchange a broad range of knowledge, to take risks with one another, to innovate, and to share information freely.

Establishing high levels of mutual expectations should enhance knowledge acquisition. Shared expectations and goals reduce the need for formal monitoring, allowing firms to invest more effort into knowledge assimilation and exploitation. Shared expectations and goals also promote the creation of compatible systems and cultures in

the dyad. Relative absorptive capacity is greatest when exchange partners have similar expectations and systems, because knowledge is embedded in the systems themselves. By testing each exchange party's ability and motivation to share knowledge so as to achieve common goals, this dynamic provides a good testing ground for possible formation of a subsequent supply-based alliance. Lane and Lubatkin's (1998) study of relations of pharmaceutical and biotech firms showed that when a 'student' firm understands or shares assumptions underlying the 'teacher' firm's systems, learning will be facilitated.

Finally, relations based on reciprocity and trust reduce time spent on monitoring and bargaining over agreements (Dyer and Singh, 1998). All else equal, less time wasted in bargaining and monitoring can mean greater time devoted to information processing and exchange. Further, because the other party can be trusted to look out for the good of the exchange partner and to be flexible about changes in circumstances, the scope of relational learning broadens (Dyer and Singh, 1998); the incentive to try new things, to experiment, and to take risks in sharing information is enhanced (Larson, 1992). In sum, the quality of the relationship between a young technology-based firm and its key customer should be positively associated with knowledge acquisition because it provides control, increases mutual understanding, quickens exchange processes, and encourages freedom in exchange. Thus, we hypothesize:

> *Hypothesis 1b: The higher the quality of the relationship with the key customer, the greater will be the young technology-based firm's knowledge acquisition from that relationship.*

Customer network ties and knowledge acquisition

The knowledge acquired as a result of a key customer relationship is not limited to that held by the key customer. The key customer may act as a link to a broad marketplace, connecting the young firm with other customers. Such ties are important for the transmission of novel information (Granovetter, 1973). Zhao and Aram (1995), for example, proposed that the range of networks influenced the growth of the six technology-based new firms they studied in China. A broad set of customer ties increases knowledge acquisition from the key customer relationship because it supplies new external knowledge. New knowledge that is different in content but similar in type to existing knowledge exposes the firm to a greater range of knowledge acquisition opportunities and enhances the firm's ability to value such opportunities. Knowledge in common is necessary for learning between two exchange partners; however, some diversity of knowledge content is required for transfer of new knowledge (Cohen and Levinthal, 1990). Indeed, recent authors have emphasized that exposure to many different external contacts is essential to learning in the new competitive environment (McEvily and Zaheer, 1999; Zahra *et al.*, 2000). Although young firms often seek to establish links with other firms in order to enhance their reputation and image (Eisenhardt and Schoonhoven, 1996; Hitt *et al.*, 2000), the learning benefits of such exposure are also important. Exposure to a variety of other customers enhances young technology-based firms' ability to assess and value the knowledge available from the key customer. Indeed, Zahra *et al.* (2000) see diversity of contact as the key to increasing the breadth, depth, and speed of an entrepreneurial firm's learning: exposure to a variety of external contacts increases the firm's 'learning by doing;' increasing new knowledge integration skills, and, thereby, the speed and depth of subsequent technological learning.

McEvily and Zaheer (1999) argue that network ties aid in the development of competitive capabilities by broadening and deepening market knowledge. They also point out that a greater number of such links means exposure to a broad set of opportunities for further learning. Besides enhancing technological learning (Zahra *et al.*, 2000), developing a broad set of customer network ties should also enhance the young firm's ability to manage its external relations. Consistent with the relational view, Lane and Lubatkin (1998) argue that such a skill will be of paramount importance in the new competitive landscape, and Hitt *et al.* (2000) argue that skill in partner selection is an important strategic tool for entrepreneurial firms. In summary, the customer ties provided by the key customer enhance knowledge acquisition by providing a framework for evaluating customer knowledge, by broadening knowledge exposure and deepening learning

skills, and by providing greater opportunities for knowledge acquisition. Thus, we hypothesize:

Hypothesis 1c: The higher the level of customer network ties provided by the key customer, the greater will be the young technology-based firm's knowledge acquisition from that relationship.

Social capital, knowledge acquisition, and knowledge exploitation

We have argued that social capital enhances knowledge acquisition by improving access to external sources of knowledge, by increasing the willingness and ability of exchange partners to identify, exchange, and assimilate knowledge, and by improving the breadth and efficiency of knowledge transfer. In the following, we posit that in young technology-based firms acquired knowledge is exploited for competitive advantage in the form of greater new product development, enhanced technological distinctiveness, and reduced sales costs.

Knowledge acquisition and new product development

Organizations learn and create innovations through knowledge communication and combination (Schumpeter, 1934; Kogut and Zander, 1992). Indeed, the creation of 'new combinations' was the essential task that Schumpeter (1934) assigned to his entrepreneur. New combinations are created by establishing novel associations between existing knowledge (Cohen and Levinthal, 1990); effective communication enhances the potential for creating such associations (Dyer and Singh, 1998).

Knowledge acquisition via relationships contributes to new product development in high-technology sectors, because new product development requires the integration and combination of specialized knowledge inputs from many different areas of technology (Cohen and Levinthal, 1990; Brown and Eisenhardt, 1998). The number of subsystems incorporated in a high-technology product is often high, and the product itself may need to be compatible with a broader technology platform and conform to several technology standards representing different types of technological competence (Anderson and Tushman, 1990). Further, successful new product development also requires inputs of relevant complementary knowledge (e.g., market, manufacturing, and design knowledge possessed by other firms). Even if technically possible, strictly in-house development of such complementary knowledge is often not economically feasible (Teece, 1986).

We propose that knowledge acquisition increases new product development in three ways: (1) by enhancing the breadth and depth of relation-specific knowledge available to the firm, thereby increasing the potential for new innovative combinations; (2) by enhancing the speed of product development through reduced development cycles; (3) by increasing the willingness of the young technology-based firm to develop new products for its key customer.

Customers are a valuable source of information for new product development (von Hippel, 1988). A key customer can provide user know-how regarding product improvement possibilities, new functional requirements, the value of prototypes, and the like. As Zahra *et al.* (2000) argue, knowledge diversity increases the depth, breadth, and speed of learning, leading to a greater number of product introductions. They also propose that technological learning provides a foundation for developing organizational routines that reinforce existing core competencies and facilitate the building of new ones; these, in turn, enhance value creation and venture performance. According to Cohen and Levinthal (1990), the degree to which outside knowledge is targeted to the focal firm's needs will influence the ease of knowledge utilization, enhancing the development of new products. In a similar vein, Lane and Lubatkin (1998) posit that the more experience the student and teacher firms have in solving similar types of problems, the easier it will be for the student firm to find commercial applications for newly assimilated knowledge.

External knowledge acquisition also shortens product development cycles, leading, *ceteris paribus*, to a greater rate of new product introductions. For example, Dyer and Singh (1998) note that relationship-specific investments both reduce the number of product defects and lead to faster product development cycles. Zahra *et al.* (2000) argue that knowledge diversity increases the speed of processing, thereby reducing product development cycles.

Finally, external relation-specific knowledge acquisition enhances product development by increasing the willingness to develop new products. When firms make relation-specific investments, their pay-off from developing new products specifically for the exchange partner increases (Dyer and Singh, 1998). This willingness is further enhanced by a better understanding of customer needs, brought about by knowledge acquisition from the key customer. Thus, we hypothesize:

Hypothesis 2a: The greater a young technology-based firm's knowledge acquisition from a key customer relationship, the higher will be the number of new products developed by the young technology-based firm as a result of that relationship.

Knowledge acquisition and technological distinctiveness

Knowledge acquisition from a key customer relationship will enhance both the depth and breadth of external knowledge available to the focal firm; such knowledge is critical to the development of technology with benefits distinct from those of competitors. Greater depth of knowledge, especially knowledge acquired via interactions with customers, enhances the ability to conceive and realize significant product differentiation (Zahra *et al.*, 2000). Richer and more varied knowledge can also be used to upgrade products, to increase customer specialization, and to understand competing and complementary technologies, thus enhancing the distinctiveness of the focal firm's technology. In this vein, Steensma (1996) has argued that learning in interorganizational relationships is an important means of acquiring technological competencies. In short, greater external knowledge acquisition from the key customer enhances the young technology-based firm's understanding of market needs, leading to more distinctive and competitive technologies. Thus, we hypothesize:

Hypothesis 2b: The greater a young technology-based firm's knowledge acquisition from a key customer relationship, the more distinctive will be the technology of the young firm.

Knowledge acquisition and reduced sales costs.

Improvement in organizational efficiency is perhaps the most studied outcome of organizational learning (Argote, 1999). The basic principle underlying the traditional learning curve models is that production experience creates knowledge that improves productivity. Learning from a key customer may result in such benefits as design economies, inbound or outbound logistics economies, or even manufacturing economies. As young technology-based firms learn to serve their key customers more effectively and efficiently, that knowledge can be applied to the manner in which they make, market, and deliver products and services to others. Innovations resulting from new external knowledge thus extend beyond product enhancements and differentiation.

In a key customer relationship, efficiency gains will be demonstrated as a reduction in the sales costs for the young technology-based firm. The more knowledge a young technology-based firm acquires about customer needs and ways of doing business, the more efficiently it will be able to provide its product or service. Improvements in efficiency can be achieved by integrating the young technology-based firm's supply activities into customers' processes or improving delivery, communication, or feedback procedures with customers. Knowledge acquired in the key customer relationship is likely to be useful in the young firm's other customer relationships as well, thus improving the overall efficiency of the firm. Thus, we hypothesize:

Hypothesis 2c: The greater a young technology-based firm's knowledge acquisition from a key customer relationship, the lower will be the sales costs of the young firm.

Mediating effect of knowledge acquisition.

The first two hypotheses link social capital with knowledge acquisition, and knowledge acquisition with three manifestations of knowledge exploitation. Implicitly, the discussion suggests that social capital affects knowledge exploitation via its effects on knowledge acquisition. While social capital provides basic elements for achieving benefits in the relationship, the organizational learning process converts social capital into tangible benefits. Thus, we propose that knowledge

acquisition mediates between social capital and technological distinctiveness, new product development, and sales costs.

Hypothesis 3: Knowledge acquisition will mediate the relationships between social capital (social interaction, quality of the relationship, and network ties) and knowledge exploitation (new product development, technological distinctiveness, and sales cost efficiency)

METHODS

Sample

We tested the hypotheses using survey data from 180 young technology-based firms in the United Kingdom. We drew the sample from the Dun and Bradstreet data base, the most comprehensive data base on company information in the United Kingdom. We had three sampling criteria: the firms had to be (1) at least 1 year, but not more than 10 years old; (2) independent, i.e., not a subsidiary; (3) involved in developing, commercializing, or manufacturing advanced technology in one of five industry sectors (1992 U.K. SIC codes): pharmaceuticals, medical equipment, communications technology, electronics, or energy/environmental technology.

We focused on young firms because they have been thought to be most affected by key external relationships (Eisenhardt and Schoonhoven, 1996). We excluded firms under 1 year old because they were less likely to have developed social capital in their key customer relationship. The 10-year upper limit is consistent with previous research on entrepreneurial firms (Covin and Slevin, 1990; Bürgel, 1999), although some theorists make a strong case for using 6 years as the cut-off for 'new' firms (Zahra *et al.*, 2000). In the United States, firms can achieve significant growth in the domestic market, and companies may go public within a few years of founding, whereas in Europe it may take between one and four decades (European Commission, 1998). In the United Kingdom, lack of equity funding has translated into longer development times for high-technology firms (Bürgel, 1999). Levels of start-up activity are more pronounced in the United States: nearly 13 percent of the working-age population are currently actively involved with either starting or managing new firms; the corresponding figure is 5 percent in the United Kingdom (Reynolds *et al.*, 2000). These differences in entrepreneurial activity and growth opportunities may also be partially due to differing cultural and regulatory conditions. Further, the phenomena we examine (such as social capital and learning) may take a significant time to develop. In short, we use a 10-year framework because of the setting and the phenomena being observed, but we refer to our sample as 'young' rather than 'new' firms. Analyses reveal that results of our hypothesis tests do not change if we include only firms in the 1- to 6-year range, although the power of the overall model is reduced.

The independence criterion ensures that effects of key customer relationships are not mixed with those of corporate parents: a corporate subsidiary might tap into its parent's knowledge base for learning, potentially clouding the effects examined here. Finally, high-technology sectors are appropriate because rapid changes in market and technological developments in these sectors make knowledge acquisition in exchange relationships particularly salient (Shan *et al.*, 1994). Butchart (1987) identified 19 high-technology SIC codes in the United Kingdom; our five industries cover 10 of these 19 codes. Finally, we chose pharmaceuticals, electronics, medical, communications, and energy/environmental technologies because they are among the most common sectors studied in interorganizational relationship research (Heide and Miner, 1992; Larson, 1992; McGee and Dowling, 1994; Nooteboom, Berger, and Noorderhaven, 1997; Tsai and Ghoshal, 1998; Zhao and Aram, 1995), and these sectors offer a sampling population in the United Kingdom adequate for cross-industry comparisons.

To ensure that sample firms were involved in technology creation, we checked their business descriptions in the source data base. Firms operating in sales and distribution with no R&D or manufacturing were excluded, as were firms offering nontechnical services only. We identified 1140 firms matching the selection criteria. We sent the questionnaire to the managing directors of these firms in May 1998. The questionnaire had been thoroughly pretested and revised as a result of discussions with 10 firms: we spoke with executives in each to ensure that no problems existed in terminology or interpretability of questions. Finally, we called all 1140 firms to ensure they fulfilled our criteria; this procedure

resulted in the elimination of 204 firms.

We received responses from 225 of the remaining 936 firms. Our response rate of 24 percent compares favorably with similar mail surveys of entrepreneurial firms: e.g., McDougall, Covin *et al.* (1994) had an 11 percent response rate in a study of new technology-based firms; Chandler and Hanks (1994) had a 19 percent response rate in a study of new manufacturing firms. Of the 225 returned questionnaires, 30 were excluded because they did not meet all sampling criteria and 15 were excluded because of incomplete answers, leaving 180 usable responses. On average, firms in the sample were 6 years old, realized £1.6 million in annual revenue, had 24 employees, and spent 30 percent of their revenue on R&D. In Bürgel's (1999) broad sample of high-tech firms in the United Kingdom, R&D intensity was just over 20 percent for firms engaging in R&D; this suggests that our sample is representative of a more technology-intensive segment. Key customers accounted for an average of 29 percent of total revenue. The average key customer was a multinational corporation with nearly 6000 employees. The sample firms were relatively evenly spread across the five sectors.

Location and age data on nonrespondents from the source data base indicate no significant differences between respondents and nonrespondents. Because those responding late are argued to be similar in composition to nonrespondents (Churchill, 1991), we also tested for response bias by comparing early against late respondents. We found no significant differences in terms of sales, employees, customer size, or international sales. The results of statistical tests for response bias suggest that our sample is representative of the population satisfying our criteria.

Reliability and validity

We took several steps to ensure data validity and reliability. First, we pretested the survey with 10 executives of young ventures (two per sector) and asked them to closely review the survey. We then revised any potentially confusing items. Following administration of the final survey, we called a random subset of 20 respondents to see if any problems with the instrument persisted, but no problems were revealed. In the instrument itself, we used previously validated measurement items wherever possible to help ensure the validity of our measures; multiple-item measures were used for most constructs to enhance content coverage. All of our multiple-item constructs achieved Cronbach alphas of 0.71 or higher, indicating strong internal consistency.

Because there are no perfect proxies for many of the critical variables in our study (such as social capital, learning, and technological distinctiveness) and no external measures for some (e.g., the number of new products developed *explicitly* as a result of the relationship with the key customer), we relied on managing directors' assessments. Thus, relationships among variables may be the result of common method variance, a potentially significant, but often overstated issue (Wagner and Crampton, 1993). We reduced the potential for common method problems by employing previously validated measures (Spector, 1987). We examined the possibility of common method variance via Harman's one-factor test for all variables in the study (Podsakoff and Organ, 1986). Significant common method variance would result in one general factor accounting for the majority of covariance in the variables. The analysis resulted in three factors with eigenvalues greater than one, with the first factor accounting for only 27 percent of total variance and the independent and dependent variables loading on different factors. Thus, common method variance is unlikely to be causing the relationships among variables in our study.

We sought to ensure reliability and validity by using multiple, time-variant measures of our constructs. For example, we obtained secondary data on sales, employee, and cost data from the Financial Analysis Made Easy (FAME) data base; we also purchased patent data from the British Library in order to examine the validity of the technological distinctiveness variable. Finally, after a 2-year lag, we resurveyed respondents on key variables in the study; this second survey focused on a portion of the original material, in a revised and shortened format (e.g., we used summary items as proxies for the original measures). We used this different, single-item format to decrease recall and consistency bias and to increase the response rate. We sent the follow-up survey to the same respondent in each firm; we did not contact a *different* person because the original respondents had not been required to disclose the identity of the key customer and we could not be certain that a new

individual would necessarily identify the same key customer from 2 years prior, especially in cases where firms have several customers of similar size. The respondents were asked to respond according to the situation as it was at the time of the initial survey. We received 117 responses to the follow-up (71% response rate; 16 firms had ceased operations or been acquired). All the validation items correlate significantly with the original measures (correlations ranging from 0.31 to 0.57). Such consistency of responses after a 2-year time period provides further evidence of the reliability of our data and the validity of our measures, and also indicates a low probability that common method variance is driving results. Further evidence regarding reliability and validity is revealed in the model testing and is discussed below.

5

Measures

The individual measurement items for the study's dependent, independent, and control variables are listed in Table 1; the construction of the measures is explained in the following. All statement-style items were measured on a scale from 1 = do not agree to 7 = completely agree.

Dependent variables

New product development

We had respondents estimate how many new products, services, or technologies their firm had developed *specifically as a result of the key customer relationship*; responses ranged from 0 to 40, with a mean of 2.3. The natural log of this measure was used in the analyses to compensate for skewness. Because no external data exist that reflect this exact measure, we took several steps to establish the validity of this measure. In order to assess the predictive validity of our measure, we examined its relationship with sales growth, from 1996 to 2000, based on the logic that some sales benefits might accrue to products developed for the key customer, even if such a relationship would be somewhat weak. We obtained sales revenue estimates for 2000 in the follow-up survey and regressed sales estimates in 2000 (log) on the number of new products developed, controlling for sales in 1996 (log), firm age, industry sector, and the growth orientation of the firm. We found that new product development in the key customer relationship was positively related to sales growth by 2000 ($b = 0.18$, $p < 0.05$), providing evidence of the predictive validity of our measure. Second, when we resurveyed the respondents in the spring of 2000, about 2 years after the original survey, we asked the managing directors to provide the number of new products that had been developed by the end of 1997 as a result of the relationship with the key customer. The elapsed time period and the inexactness of estimating the number of new products in existence at a particular point in time from one particular relationship made an excessively high correlation unlikely. Nonetheless, the measure from the follow-up survey correlated strongly with our original measure ($r = 0.38$, $p < 0.001$), suggesting construct validity.

6

Technological distinctiveness

We measured the firm's technological distinctiveness or superiority with three statements regarding the extent to which the firm's technology is a source of competitive advantage for the firm; we defined the company's technology as 'the company's technological skills and knowledge as well as the products, services, and processes based on these skills and knowledge.' The items were designed based on Wernerfelt (1984) and Conner (1991). Given our sampling criterion of involvement in technology creation, we expected sample firms to generally perceive themselves as having technology as a source of competitive advantage; therefore, the relatively high mean on the variable (4.83 on a 7-point scale) suggests some degree of face validity. Further, the measure in the follow-up survey correlated significantly with our original measure ($r = 0.57$, $p < 0.001$), providing further evidence of validity.

7

As external validation for technological distinctiveness, we used data on the firms' number of patents. Although Grant (1996) points out that number of patents is a weak proxy for knowledge or technological sophistication because of strategic reasons why firms may avoid obtaining patents, we reasoned that, on average, the more distinctive or sophisticated a firm's technology, the more patents it would have. Given the cost of obtaining this information on private firms, we purchased patent information from the British Library for 90 of our sample firms (the bottom

Table 1. Measurement model

Factor name	Measurement item	Standardized loading	Z-statistic	Composite reliability[a]	Average variance extracted
Social interaction				0.71	0.55
	We maintain close social relationships with this customer	0.76			
	We know this customer's people on a personal level	0.72***	3.76		
Relationship quality				0.73	0.49
	In this relationship both sides avoid making demands that can seriously damage the interests of the other	0.57			
	In this relationship neither side takes advantage of the other even if the opportunity arises	0.84***	5.90		
	This customer always keeps its promises to us	0.67***	6.18		
Customer network ties				0.86	0.76
	We have got new customer contacts through this customer	0.80			
	This customer has 'opened the doors' of other customers for us	0.94***	7.64		
Knowledge acquisition				0.85	0.59
	Because we supply to this customer we are able to obtain a tremendous amount of market knowledge	0.72			
	We get most of our valuable information on customer needs and trends from this customer	0.82***	9.85		
	Because we supply this customer we are able to obtain a tremendous amount of technical know-how	0.77***	9.40		
	We get most of our valuable technical know-how related to supplying our product/service from this customer relationship	0.76***	9.28		

Continued

Table 1. Continued

Factor name	Measurement item	Standardized loading	Z-statistic	Composite reliability[a]	Average variance extracted
Technological distinctiveness				0.79	0.61
	Our technology is better than competitors' technology	0.61			
	Our competitive advantage is based on our technology	0.79***	8.08		
	We invest very heavily in R&D	0.92***	7.81		
New product development					
	Number of new products developed as a result of the key customer relationship (logarithm)	1.00			
Sales costs	Percent of total sales revenue in 1997, logarithm	1.00			
Firm size	Number of employees in 1997, logarithm	1.00			
Firm age	Years since founding	1.00			
Economic exchange with key customer					
	Sales to key customer as percent of total sales, 1997	1.00			
Internationalization					
	International sales as percent of total sales, 1997	1.00			

***$p \leq 0.001$; [a]analogous to Cronbach alpha

25% and top 25% of firms on our technological distinctiveness measure). The correlation between the number of patents and technological distinctiveness was 0.31 ($p < 0.001$). This is a surprisingly strong relationship, given that firms may have distinctive technologies that are not suitable for patenting or firms may patent technologies that are only marginally distinctive. To explore the relationship further, we regressed the number of patents on technological distinctiveness, while controlling for firm age, size, and industry, and found technological distinctiveness positively related to the number of patents ($b = 0.36$, $p < 0.001$). This strong relationship provides evidence of the external validity of our technological distinctiveness construct. For additional validation of this measure, we searched the Internet, reasoning that the greater the distinctiveness, the greater the number of times the firm's name might appear. The content of 20 randomly selected web pages indicated that they indeed emphasized firms' technologies, instead of, for example, low prices. We regressed the number of web page citings for each firm on technological distinctiveness (controlling for firm age, size and industry sector) and found the number of web citations positively related to technological distinctiveness ($b = 0.13$, $p < 0.10$). The correlation between the numbers of patents and web citations was 0.44 ($p < 0.001$). These relationships provide some additional external confirmation of construct validity for our technological distinctiveness measure.

Sales costs

Overall sales and marketing costs were measured as a percentage of total sales revenue in 1997. The natural logarithm was used to compensate for the effects of a few firms with very high costs as a percentage of sales (due to extremely small revenue figures for very young firms). To validate our measure, we obtained secondary sales cost data from the FAME data base; data were available for 42 of the sample firms. The secondary data were highly consistent with the self-reported figures ($r = 0.71$, $p < 0.001$).

In short, although no perfect proxies for the dependent variables in this study existed, information in follow-up surveys and in the secondary data consistently suggest the validity of the Managing directors' assessments. Furthermore, the factor and model tests conducted (see Results section) also consistently suggest the reliability of the data and the lack of common method variance as an explanation for the relationships among the variables.

Independent variables

Knowledge acquisition in the relationship

We measured knowledge acquisition with four statements reflecting the technological and market knowledge that a young technology-based firm may acquire from the key customer. The items were based on Huber (1991), Nooteboom *et al.* (1997) and von Hippel (1988). Survey-based measures of organizational learning have previously been used effectively by Simonin (1997), Zander and Kogut (1995), and Zahra *et al.* (2000). Further, the 10 executives that we interviewed in the pretest stage all suggested that this approach was appropriate for assessing knowledge acquisition. For reasons discussed earlier, we expected moderate correlations between the original measures and the single-item measures used in the follow-up survey. The measure for knowledge acquisition in the follow-up survey correlated significantly with our original measure ($r = 0.36$, $p < 0.001$).

Social interaction

We measured social interaction with two statements reflecting the extent to which the relationship is characterized by personal, social ties between the young technology-based firm and the customer. This dimension of social capital was modeled after Nahapiet and Ghoshal (1998) and Tsai and Ghoshal (1998). The measure for social interaction in the follow-up survey correlated significantly with our original measure ($r = 0.47$, $p < 0.001$).

Relationship quality

We measured relationship quality with three statements reflecting the extent to which the young technology-based firm perceives trust between itself and the key customer. Relationship quality, or trust, has been previously used as a dimension of social capital by, for example, Leana and Van Buren (1999), Moran and Galunic (1998), and Nahapiet and Ghoshal (1998). The first item (see

Table 1) was adopted from Heide and Miner (1992); it has also been used by Nooteboom *et al.* (1997). The other two items were adopted from Tsai and Ghoshal (1998). The measure for relationship quality in the follow-up survey correlated significantly with our original measure ($r = 0.31$, $p < 0.001$).

Customer network ties

We measured customer network ties with two statements reflecting the degree to which the key customer relationship provides the young technology-based firm with a network of customer contacts. This social capital construct was designed based on Larson (1992) and Uzzi (1997). The measure for customer network ties in the follow-up survey correlated significantly with our original measure ($r = 0.33$, $p < 0.001$).

Control variables

Firm age

The age of the firm may have an influence on the firm's ability to learn in the customer relationship and on knowledge exploitation (Lane and Lubatkin, 1998; Zahra *et al.*, 2000). Older firms may have an experience advantage, or, alternatively, younger firms may have a higher capacity to take in new knowledge (Autio *et al.*, 2000). Therefore, we included firm age as a control variable.

Firm size

The size of the firm may influence knowledge acquisition and knowledge exploitation (Autio *et al.*, 2000); larger ventures may have more resources to devote to the key customer relationship. Firm size was measured as the number of employees in 1997 (log). The employee figures were validated using data from the FAME data base. The secondary data, available for 42 of the sample firms, were nearly identical to the self-reported figures ($r = 0.98$, $p < 0.001$).

Economic exchange

The magnitude of economic exchange may affect the level of social capital, knowledge acquisition, and knowledge exploitation of a key customer relationship. Thus, to examine effects of social capital and knowledge acquisition *beyond* the effects of economic exchange, we controlled for the level of economic exchange. We measured economic exchange as the *percentage* of total sales accounted for by the key customer in 1997. This is the most commonly used measure of economic dependence (Heide and John, 1988; Jacobs, 1974; Nooteboom *et al.*, 1997). As a relative measure, it is more comparable across firms than an absolute measure which may be subject to differences depending on age, size, and industry sector.

Internationalization

The international diversity of a young firm may affect its level of knowledge acquisition and exploitation (Autio *et al.*, 2000). For example, Zahra *et al.* (2000) found that international expansion had a positive effect on a firm's technological learning and on the firm's performance. Because internationalization may be correlated with the level of social capital achieved by a firm, it is important to partial out the effects of internationalization in examining knowledge acquisition and exploitation. Therefore, we included international sales as percentage of total sales in 1997 as a control variable.

Industry sector

Because exchange processes, knowledge acquisition, and relationship outcomes vary by industry sector (Lane and Lubatkin, 1998), we included dummy variables to control for industry effects. A firm's industry, originally determined by the primary SIC code in the source data base, was confirmed by using the business description obtained in the survey.

Structural equation modeling method

The hypotheses were tested using structural equation modeling, which is a combination of factor analysis and path analysis. We followed the two-stage procedure recommended by Anderson and Gerbing, 1988). In the first stage, the measurement model was estimated using confirmatory factor analysis in order to test whether the constructs exhibited sufficient reliability and validity. The second stage identified the structural model

that best fit the data and tested the hypothesized relationships between the constructs.

RESULTS

Measurement model

Table 1 summarizes the results of confirmatory factor analyses on the measurement model. The measurement items for each construct (factor) are presented, and the standardized factor loadings and their associated *Z*-statistics, where applicable, are reported; composite reliabilities and the variance extracted are also listed. As the factor loadings indicate, the measurement model performed very well. The standardized factor loadings are all above 0.57 (recommended minimum in the social sciences is usually 0.40 (Ford, McCallum, and Tait, 1986)). The composite reliabilities, analogous to Cronbach alpha values, are all above the recommended minimum of 0.70. The average variances extracted range from 0.49 to 0.76 (recommended minimum 0.50 (Fornell and Larcker, 1981)). Thus, all of the constructs demonstrate good internal consistency and, hence, reliability.

The measurement model can be used to evaluate discriminant validity. Constructs demonstrate discriminant validity if the variance extracted for each is higher than the squared correlation between the constructs (Fornell and Larcker, 1981). We examined each pair of constructs in our measurement model and found that all demonstrate discriminant validity. Convergent validity is also evident: positive correlations exist among the three social capital constructs, as is expected for constructs representing different dimensions of the same underlying concept. Table 2 reports means, standard deviations, ranges, and correlations for the variables of the study.

As Table 3 shows, the overall fit of the (saturated) measurement model is good. Values close to or above 0.90 on the goodness-of-fit index and Bollen's incremental fit index are desirable. The Bentler–Bonett normed fit index indicates the extent to which the model improves fit compared to a random model; e.g., 0.80 would indicate an 80 percent improvement over the null (Schumacker and Lomax, 1996). The recommended range for the normed chi-square statistic is between 1.0 and 2.0 (Hair *et al.*, 1995). Thus, the results indicate that all of the constructs are adequate for use in the second stage.

Nested model tests

We employed nested model tests (Loehlin, 1987) to assess the fit of the hypothesized model. Nested model tests help internally validate a hypothesized model by comparing the chi-squares of models that differ in the number of paths hypothesized; nested models can be derived by adding or deleting paths. A significant difference in chi-square indicates that the more complex model provides a better fit with the data. We compared Models 1–4 in Table 3 by using sequential chi-square difference tests to obtain successive fit assessments (Steiger, Shapiro, and Browne, 1985). The four nested models are: (1) a null model, in which no relationships are posited; (2) a saturated model, in which direct and indirect effects of the social capital constructs on knowledge exploitation are included (this is the measurement model); (3) the hypothesized mediation model, which includes only indirect effects of the social capital constructs on knowledge exploitation through knowledge acquisition; (4) a direct model, which includes only direct effects of social capital on knowledge exploitation. Table 4 summarizes the testing sequence.

The goodness-of-fit statistics (Table 3) and the chi-square difference test (Table 4) indicate that the saturated model provides a better fit than the null model. In the second step, the hypothesized model is compared to the saturated model. The hypothesized model posits the removal of nine paths (the direct paths from social capital to knowledge exploitation) from the saturated model. The goodness-of-fit statistics are nearly identical for the hypothesized and the saturated models. Only one of the direct paths in the saturated model is statistically significant, namely the path from customer network ties to technological distinctiveness. In Table 4 (second row), the difference in chi-square is not significant, indicating that the more parsimonious, hypothesized model (Model 3) provides a better fit with the data than the saturated model.

In Model 4 we examine the direct effects of social capital on the three dimensions of knowledge exploitation. The goodness-of-fit statistics for the direct model are slightly lower than for the hypothesized model. Note that the direct model cannot be compared to the hypothesized model with a chi-square difference test, since the models are not nested. A comparison between

Table 2. Means, standard deviations, ranges, and correlations for the variables in the model

	1	2	3	4	5	6	7	8	9	10	11
1 Social interaction											
2 Relationship quality	0.15*										
3 Customer network ties	0.14+	0.17*									
4 Knowledge acquisition	0.27***	–0.04	0.38***								
5 Economic exchange	0.15+	0.14+	–0.15*	0.09							
6 Firm age	–0.10	0.05	–0.14+	–0.15+	0.09						
7 Firm size	0.01	–0.19*	–0.04	0.04	–0.11	0.16*					
8 Internationalization	0.00	–0.06	–0.16*	–0.02	0.13+	0.11	0.19*				
9 Number of new products developed	0.13+	–0.08	0.19*	0.28***	0.08	–0.11	0.17*	–0.05			
10 Technological distinctiveness	0.08	–0.02	0.18*	0.23**	0.04	–0.04	0.08	0.28***	0.05		
11 Sales costs	0.05	–0.05	0.03	–0.15*	–0.03	–0.06	–0.09	–0.03	–0.25**	0.04	
Mean	4.28	4.92	3.99	3.39	28.92	5.96	23.81	34.03	2.25	4.83	33.34
S.D.	1.71	1.32	1.88	1.46	23.92	2.79	46.94	33.45	4.58	1.57	54.44
Min.	1.00	1.00	1.00	1.00	0.01	1.00	0.00	0.00	0.00	1.00	0.00
Max.	7.00	7.00	7.00	7.00	100.00	10.00	380.00	100.00	40.00	7.00	600.00

N = 180. For firm size, number of new products developed, and sales costs, natural logarithms are used in correlations, but actual values are reported in descriptive statistics. ***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$, +$p \leq 0.10$; two-tailed tests

Table 3. Model statistics

Model	Chi²	*P*[a]	d.f.	GFI	IFI	NFI	Normed chi²
1. Null model	1498.03	0.00	276	0.57	0.00	0.00	5.43
2. Saturated (measurement model)	280.36	0.00	160	0.89	0.91	0.81	1.75
3. Hypothesized (mediation model)	289.92	0.00	169	0.89	0.91	0.81	1.72
4. Next-best constrained (direct effects model)	290.84	0.00	163	0.88	0.90	0.80	1.78

GFI = Jöreskog and Sörbom's goodness-of-fit index, compares predicted squared residuals with obtained residuals, not adjusted by degrees of freedom; IFI = Bollen's incremental fit index, compares proposed model to null model, adjusted by degrees of freedom; NFI = Bentler–Bonett normed fit index, compares proposed model to null model, not adjusted by degrees of freedom; Normed chi-square = chi-square adjusted by degrees of freedom.

[a]A significant chi-square statistic indicates significant differences between the model and the data, and would seem to suggest rejection of the model. However, this statistic has a tendency to become overly sensitive with high degrees of freedom and/or with large sample sizes. It is therefore generally recommended that other goodness-of-fit statistics be used to assess overall model fit and that the chi-square statistic is most useful in comparisons between alternative models (Hair *et al.*, 1995; Schumacker and Lomax, 1996).

Table 4. Nested model testing sequence and difference tests

Comparison		Chi² diff.	d.f. diff.	*P*	Model preference
Model 2 vs. 1	Saturated vs. null	1217.67	116	<0.005	2
Model 3 vs. 2	Hypothesized vs. saturated	9.46	9	>0.10	3
Model 4 vs. 2	Direct vs. saturated	10.48	3	<0.05	2

the direct model and the saturated model results in a significant difference in chi-square, indicating that the saturated model is preferred.

In summary, the nested model tests indicate that the hypothesized mediation model fits the data better than the saturated or the direct models. We can now use the hypothesized model to test Hypotheses 1 and 2. To further examine the mediating role of knowledge acquisition (Hypothesis 3), we compare the path coefficients of the hypothesized, saturated, and direct models.

Hypothesis tests

Table 5 presents the standardized maximum likelihood parameter estimates and their *Z*-statistics for the hypothesized path model. The first six rows present the results of the tests for Hypotheses 1 and 2; the remaining rows present control paths. Figure 2 illustrates the hypothesized model with the parameter estimates for the hypothesized relationships.

Hypothesis 1 predicts that social capital is positively related to knowledge acquisition in a firm's key customer relationship. Table 5 indicates that social interaction is positively related to knowledge acquisition, providing support for Hypothesis 1a. In direct contrast with Hypothesis 1b, relationship quality is *negatively* related to knowledge acquisition. Customer network ties are positively related to knowledge acquisition, providing support for Hypothesis 1c.

The second set of hypotheses examines the impact of knowledge acquisition in the customer relationships on knowledge exploitation. All three hypotheses (Hypotheses 2a–2c) are supported. First, Table 5 shows that knowledge acquisition is positively related to the number of new products developed and to technological distinctiveness, providing support for Hypotheses 2a and 2b, respectively. Further, the higher the knowledge acquisition, the lower are the sales costs of the young firm, providing support for Hypothesis 2c.

Hypothesis 3 states that knowledge acquisition mediates the relationship between the social capital constructs and knowledge exploitation. We tested this hypothesis by first examining the results of the nested model tests and then looking

Table 5. Structural equation modeling results: standardized maximum likelihood path coefficients for the hypothesized model

			Hypothesized model 3	
	Description of path	Hypothesized direction	Coefficient	Z-statistic
H 1a	Social interaction → Knowledge acquisition	+	0.19*	1.99
H 1b	Relationship quality → Knowledge acquisition	+	−0.17*	−1.89
H 1c	Customer network ties → Knowledge acquisition	+	0.49***	4.98
H 2a	Knowledge acquisition → New product development	+	0.28***	3.44
H 2b	Knowledge acquisition → Technological distinctiveness	+	0.28***	3.15
H 2c	Knowledge acquisition → Sales costs	−	−0.18*	−2.27
Controls	Firm age → Knowledge acquisition		−0.03	−0.45
	Firm age → New product development		−0.06	−0.78
	Firm age → Technological distinctiveness		−0.06	−0.84
	Firm age → Sales costs		−0.07	−0.90
	Firm size → Knowledge acquisition		0.07	0.92
	Firm size → New product development		0.21**	2.77
	Firm size → Technological distinctiveness		−0.02	−0.25
	Firm size → Sales costs		−0.04	−0.58
	Economic exchange → Knowledge acquisition		0.22**	2.87
	Economic exchange → New product development		0.09	1.17
	Economic exchange → Technological distinctiveness		−0.00	−0.02
	Economic exchange → Sales costs		0.02	0.32
	Internationalization → Knowledge acquisition		0.03	0.43
	Internationalization → New product development		−0.06	−0.89
	Internationalization → Technological distinctiveness		0.21**	2.62
	Internationalization → Sales costs		−0.08	−1.03
	Pharmaceutical industry → Knowledge acquisition		−0.01	−0.08
	Pharmaceutical industry → New product development		−0.12+	−1.35
	Pharmaceutical industry → Technological distinctiveness		−0.12	−1.21
	Pharmaceutical industry → Sales costs		0.13+	1.44
	Telecom industry → Knowledge acquisition		−0.00	−0.02
	Telecom industry → New product development		0.02	0.17
	Telecom industry → Technological distinctiveness		−0.08	−0.09
	Telecom industry → Sales costs		0.08	0.87
	Medical equipment industry → Knowledge acquisition		0.04	0.38
	Medical equipment industry → New product development		0.12+	1.35
	Medical equipment industry → Technological distinctiveness		−0.04	−0.44
	Medical equipment industry → Sales costs		0.18*	1.97
	Energy/environmental industry → Knowledge acquisition		0.14+	1.45
	Energy/environmental industry → New product development		0.03	0.35
	Energy/environmental industry → Technological distinctiveness		−0.37***	−3.58
	Energy/environmental industry → Sales costs		−0.14+	−1.50

***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$; +$p \leq 0.10$; one-tailed tests

into the specific relationships between the constructs. In the nested model tests, the hypothesized mediation model provided a better fit than the alternative models including only direct effects (Model 4) or both direct and mediated effects (Model 2). This result provides evidence in support of the role of knowledge acquisition in mediating the effects of social capital. Note that in the saturated model the direct path from customer network ties to technological distinc-

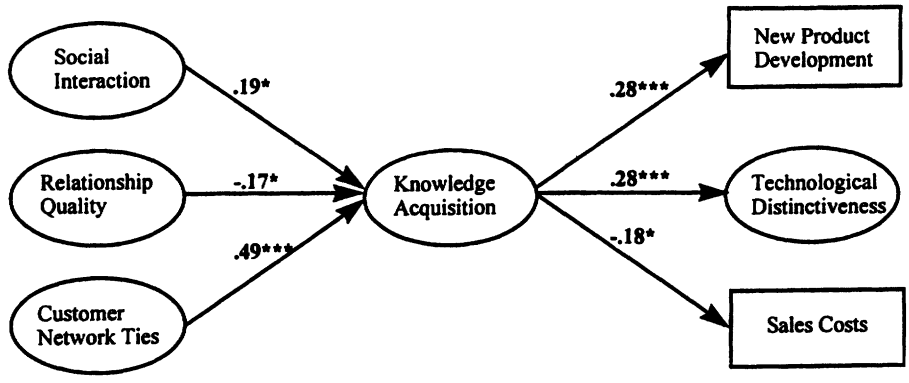

Figure 2. Standardized maximum likelihood parameter estimates for the hypothesized model. This is a simplified version of the actual model. It does not show error terms, control variables, or the indicator variables of the latent constructs. An exogenous unobserved error variable was attached to each of the endogenous variables to account for the variance not explained by the observed exogenous variables. The error coefficients were fixed to unity to enable model identification. Economic exchange, firm age, firm size, degree of internationalization, and the industry indicators were included in the model as control variables. Path coefficients are standardized maximum likelihood parameter estimates. Latent variables are represented by ovals; observed variables are represented by rectangles. $^{***}p \leq 0.001$; $^{**}p \leq 0.01$; $^{*}p \leq 0.05$; one-tailed tests

tiveness was statistically significant. This suggests that, in this case, knowledge acquisition may have a *partially* mediating role.

To demonstrate mediation for specific relationships, we examined the three conditions necessary for mediation (Baron and Kenny, 1986). First, the predictors (social interaction, relationship quality, and customer network ties) must be related to the mediator (knowledge acquisition). Second, the mediator must be related to the dependent variables (technological distinctiveness, new product development, and sales costs). Third, the previously significant relationship between the predictor variables and dependent variables should be eliminated or substantially reduced when the mediator is accounted for. The condition that the predictor variables be related to the mediator is satisfied by the path coefficients for the direct model: the first column in Table 6 shows that all three social capital constructs are significantly related to knowledge acquisition. The significant relationships between knowledge acquisition and all three forms of exploitation (column 2 of Table 6) satisfies the second condition for mediation. To satisfy the third condition, social capital variables should have significant relationships with knowledge exploitation in the direct model, but relationships should be substantially reduced in the saturated model. Column 1 shows that social interaction is positively related to new product development and to technological distinctiveness, but relationship quality is negatively related to new product development; customer network ties are positively related to product development and to technological distinctiveness. Thus, mediation is possible in five instances (in bold in the table). In the saturated model (column 3), four of the five direct paths are no longer significant, providing evidence of mediation. The remaining significant direct path is between network ties and technological distinctiveness, and even here the significance of the path coefficient is reduced.

In summary, the nested model tests suggested that a mediation model fit our data better than a saturated or a direct effects model. Tests of specific paths revealed that knowledge acquisition mediates the relationships between (1) social interaction and new product development, (2) social interaction and technological distinctiveness, (3) relationship quality and new product development, and (4) customer network ties and new product development. Knowledge acquisition also partially mediates between network ties and technological distinctiveness.

Control variable effects

The only significant relationship between a control variable and our mediating variable is the positive association between economic exchange and knowledge acquisition (see Table 5). In terms of knowledge exploitation, several relationships

Table 6. Test of mediation: comparison of the standardized path coefficients for the direct, hypothesized, and saturated models

Path	Direct model	Hypothesized model	Saturated model
Social interaction → Knowledge acquisition	0.21*	0.19*	0.19*
Social interaction → New product development	**0.12**$^{+}$		**0.07**
Social interaction → Technological distinctiveness	**0.15**$^{+}$		**0.11**
Social interaction → Sales costs	−0.02		0.03
Relationship quality → Knowledge acquisition	−0.19*	−0.17*	−0.17*
Relationship quality → New product development	**−0.14**$^{+}$		**−0.09**
Relationship quality → Technological distinctiveness	−0.08		−0.05
Relationship quality → Sales costs	−0.02		−0.08
Customer network ties → Knowledge acquisition	0.49***	0.49***	0.48***
Customer network ties → New product development	**0.23****		**0.12**
Customer network ties → Technological distinctiveness	**0.27****		**0.20***
Customer network ties → Sales costs	−0.05		0.10
Knowledge acquisition → New product development		0.28***	0.19*
Knowledge acquisition → Technological distinctiveness		0.28***	0.14^{+}
Knowledge acquisition → Sales costs		−0.18*	−0.24**

Economic exchange, firm age, firm size, degree of internationalization, and the industry indicators were included in each model as control variables. Since their effects are reported in Table 5, they are not reported here.
***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$; $^{+}p \leq 0.10$; one-tailed tests
Numbers in bold indicate the instances where mediation is possible

may be observed: firm size is positively related to new product development; extent of internationalization is positively related to technological distinctiveness; and technological distinctiveness is lower in the energy/environmental sector while sales costs are higher in the medical equipment sector.

DISCUSSION

We posited that social capital may be related to the amount of external knowledge acquired and exploited by young technology-based firms. Consistent with the relational view, we focused on knowledge exploitation for competitive advantage that might accrue to a young firm via external knowledge acquired in its relationship with its major customer. We tested our ideas with survey data from 180 firms in five high-technology sectors in the United Kingdom. Our results indicate that social interaction and network ties are positively related to knowledge acquisition, but that relationship quality is negatively related to knowledge acquisition. Further, we find that knowledge acquisition is positively related to new product development, technological distinctiveness, and sales cost efficiency. We also find support for a mediating role of knowledge acquisition between social capital and knowledge exploitation.

The positive association between social interaction and knowledge acquisition is consistent with assumptions that learning, particularly that involving difficult-to-transfer information, is aided by intensive, repeated interactions. In support of prior suggestions (Lane and Lubatkin, 1998; Tsai and Ghoshal, 1998), our results indicate that social interaction may facilitate learning by fostering close, intensive information exchange. Furthermore, key customers aid in knowledge acquisition by providing introductions to other customers and their knowledge bases. Access to external knowledge bases expands learning opportunities and can aid in development of knowledge integration skills (Dyer and Singh, 1998; Zahra *et al.*, 2000).

Our prediction that relationship quality would enhance knowledge acquisition is not supported: relationship quality is *negatively* associated with knowledge acquisition. One possible explanation is that key customer relationships may suffer from 'overembeddedness.' Uzzi (1997), for example, posited that very close relationships insulate small firms from other external sources of information. Another explanation is that as relationship quality (or trust) reaches a very high level, the perceived

need to monitor diminishes, decreasing the level of conflict and of intense processing of information. While lowered monitoring and bargaining may reduce the cost of knowledge exchange (Dyer and Singh, 1998), they may also lower the amount of new knowledge acquired. Consistent with this explanation, Nahapiet and Ghoshal (1998) noted that some dimensions of social capital may at times also inhibit exchange and combination processes, constraining rather than enabling learning. Similarly, if trust reaches a very high level, the expectation may exist that information will be provided when needed, so that the incentive to acquire external knowledge is reduced. In short, a high level of trust may allow a relationship to run smoothly and may reduce some of the transaction costs associated with managing the customer relationship but may not actually increase knowledge acquisition.

Our results provide strong support for our second set of hypotheses that suggest that knowledge acquisition can be exploited to enhance the competitive position of young technology-based firms. We find that young technology-based firms that acquired greater market and technological knowledge through their key customer relationships produced a greater number of new products, developed greater technological distinctiveness, and realized lower overall sales costs. The first of these findings is consistent with previous studies showing interorganizational relationships positively related to innovative output (Deeds and Hill, 1996; Shan *et al.*, 1994). Our result sheds new light on these studies by identifying knowledge acquisition as a mechanism through which interorganizational relationships benefit new product development. This result also supports theorists who emphasized the importance of acquiring external knowledge to product development, particularly from customers (Rosenberg, 1982; von Hippel, 1988).

Although the positive relationship between knowledge acquisition and technological distinctiveness is consistent with our learning framework, some researchers have argued that entrepreneurial firms are in danger of losing creativity and innovativeness if they become too dependent on one or a few customers. Christensen (1997) argued that such reliance in new product development can erode the ability to make radical innovations. Yet we find knowledge acquisition from a key customer positively related to technological distinctiveness. Thus, our results are also in contrast to the suggestion that young technology-based firms may lose their distinctive technologies through expropriation by powerful customers (Deeds and Hill, 1996). Instead, at least in the short term, young technology-based firms may benefit in terms of technological distinctiveness from acquiring knowledge from their key customers. Furthermore, the significant positive relationship between economic exchange and knowledge acquisition (see Table 5) suggests that customers representing a larger percent of a young firm's sales revenues may feel a greater obligation to supply or share information needed by the entrepreneurial firm.

The fact that knowledge acquisition is also significantly related to sales cost efficiency provides further support for the robustness of the knowledge-based view. This finding suggests that knowledge acquisition in the key customer relationship may improve the efficiency of the young technology-based firm's operations as a whole. This result is consistent with Dyer and Singh's (1998) position that effective governance in interorganizational relationships improves the efficiency of exchange, and it is also consistent with Zahra *et al.* (2000), who argue that increases in knowledge integration skills strengthen other core competencies and may therefore lead to greater effectiveness in a variety of domains.

The results support the hypothesis that knowledge acquisition mediates the relationship between social capital and knowledge exploitation and are thus consistent with the suggestions of Steensma (1996) and Zahra *et al.* (2000), who propose that the process of learning *converts* interorganizational interaction into core competencies. Knowledge acquisition appears to be a key mechanism by which collaboration is leveraged for the development of both technical competencies and cost efficiencies.

In short, our results highlight the important intersection of entrepreneurship and strategic management. Strategic management literature suggests that a firm may create greater wealth by enhancing the price customers are willing to pay, by producing at lower costs, or by producing goods and services more rapidly (Hitt *et al.*, 1999); our knowledge exploitation variables roughly correspond to these three avenues to wealth creation for the firm. Entrepreneurship literature emphasizes the value of leveraging

external resources and creating new combinations. We show here that by leveraging social capital to acquire external knowledge and by exploiting this knowledge young technology-based firms may accomplish strategic and entrepreneurial objectives.

Implications for theory and practice

Our findings contribute to social capital and knowledge-based research in several ways. First, whereas past research has focused on social capital as a macro-level concept in industry networks (Burt, 1992; Walker, Kogut, and Shan, 1997) or as a micro-level concept *within* organizations (Moran and Galunic, 1998; Tsai and Ghoshal, 1998), we show that the concept of social capital is applicable also to interorganizational strategy. Second, previous research has often focused on a single dimension of social capital and measured it indirectly as the number of relationships or network position (Walker *et al.*, 1997; Burt, 1992). We operationalized three dimensions of social capital; results indicate that these dimensions are distinct and have differential effects on knowledge acquisition. This finding is important because it provides empirical support for propositions in recent research that different social assets may have different effects on relationship outcomes (e.g., Dyer and Singh, 1998; Uzzi, 1997). Further, we showed how knowledge acquisition and competitive advantage may be facilitated through relational assets. Finally, in the organizational learning literature, Argote (1999), among others, has called for studying a variety of learning outcomes. We take a step in this direction by exploring both tangible (new product development, sales costs) and intangible (technological distinctiveness) outcomes; in so doing, we contribute to the development of operationalizations for knowledge-based constructs (Spender and Grant, 1996).

This study helps address the need to detail and to test emerging theories of value creation and thus provides evidence of the value of integrating concepts from strategic management and entrepreneurship. Theories of cost minimization (e.g., agency, transaction cost) dominated the strategy literature until recent attention to resource-based, knowledge-based, and social capital theories. We propose that social capital in young technology-based firms' key customer relationships enhances the acquisition of valuable knowledge and paves the way for creation of new combinations that may be exploited for competitive advantage. Thus, we help link social capital with knowledge-based concepts of value creation as an explanation of competitive advantage.

From a practical point of view, our study indicates that key customer relationships offer significant learning opportunities for young technology-based firms. Entrepreneurs may be able to actively manage their firm's social capital to stimulate knowledge acquisition and build competitive advantage. Furthermore, intense knowledge-exchanging relationships between young firms and their customers can form the basis for alliances or cooperative ventures that may eventually lead to even greater wealth-creating opportunities. At the same time, our results indicate that young technology-based firms should at a minimum be aware of the potential downsides of building social capital and relying on a key customer for external knowledge. Finding the optimal level of social capital is therefore a challenge for entrepreneurs.

Limitations and future directions

Noting the limitations of our study may provide ideas for extension and improvement. Factors unique to the United Kingdom, to the late 1990s, and to the five technology-based sectors may limit the applicability of the results to other settings. As Tyre and von Hippel (1997) point out, learning is a situated process embedded in its social, cultural, and physical setting; e.g., because the United Kingdom is a relatively small country, it makes proximity to the key customer more likely and may thereby enhance the potential for relational effects (Dyer and Singh, 1998). Bürgel (1999) found that the number one trigger for international sales among young high-technology firms in the United Kingdom was personal contacts; thus, relational factors may be more important in the United Kingdom than in larger markets such as the United States. Further, it is possible that the results would not hold in less dynamic, low-technology environments or for older firms. Our sample was particularly R&D intensive; it is unclear how well our results would generalize to a broader sample. At the same time, our narrow focus helped to control for industry- and country-specific differences that might have

otherwise masked significant effects. In short, future studies conducted in other industry and country settings may shed light on the generalizability of the theoretical positions developed here.

Although causal relationships have been proposed or implied at various places in this study, the cross-sectional nature of our design prevents testing the direction of relationships. Therefore, it is possible that the causality may flow in an opposite direction to that proposed (e.g., perhaps knowledge acquisition promotes social interaction) or may be reciprocal. However, we have rooted our arguments in existing theory and past results. Future longitudinal research may help to sort out whether reverse or reciprocal relationships exist.

A methodological limitation partly inherent in knowledge-based research is the difficulty of measurement. Secondary and objective data offer the value of verifiability and replicability, with the potential for some freedom from bias. At the same time, they are often imprecise proxies for the constructs of interest. In this study, we chose self-reported measures both because of their potential for concept-specific accuracy and because of the unavailability of other measures across an entire sample. Another limitation of the study is possible survivor bias: our sample includes only young technology-based firms that have survived, and it may be that different relationships would emerge if failed firms had been included in our sample.

Biases inherent in the perspectives of the young technology-based firms may also affect results. Because the focus of the study was on the learning processes of young technology-based firms and because of the reluctance of young technology-based firms to involve their key customers in our study, we deemed prudent the decision to keep customer identity confidential. Nonetheless, future research that focuses on the customer side may yield further insights into mutual knowledge acquisition and exploitation. An additional direction in future research may be to examine the entire network of customer relationships for young technology-based firms.

Several other paths for future study of social capital, learning, and competitive advantage for entrepreneurial firms also appear interesting. For example, does learning increase a young firm's chances of survival? Venkataraman *et al.* (1990) found that for entrepreneurial firms a failure in transactions with key customers might lead, in domino fashion, to the dissolution of other relationships and ultimate failure. It would be interesting to see whether such failures might be influenced not only by external factors, as suggested by Venkataraman *et al.* (1990), but also by social capital and knowledge processes in the relationships. Another interesting issue to study would be the leakage of proprietary technology. In the present study, the technological distinctiveness variable partially captured this potential risk of close exchange relationships, but it might be productive to study more explicitly how knowledge exchange influences the expropriation of technology by the exchange partner. In short, more work is needed on the potential costs of building and maintaining social capital.

At least two other very important areas deserve further attention. More can be learned, for example, about how social capital can be fostered. Earlier recursive models of the development of cooperative interorganizational relationships (e.g., Ring and Van de Ven, 1994) provide good theoretical bases for further empirical study of cooperative learning. The *process* of learning in interorganizational relationships also merits closer qualitative and longitudinal examination. Interactions among the elements of social capital may affect knowledge acquisition; supplementary analyses of our data did not reveal significant relationships, but our power to detect such relationships was limited by sample size. Second, our study focused on knowledge acquisition and exploitation, but we did not examine the intermediate assimilation phase, and we focused on exploitation outcomes rather than processes. As Lane and Lubatkin (1998) argue, different skills characterize the abilities to acquire, assimilate, and exploit external knowledge. Further, different types of knowledge may hold different implications for the process.

We set out to contribute to the understanding of the roles of social capital and knowledge acquisition for young technology-based firms in building competitive advantage. Results show that social capital is associated with knowledge acquisition, and that knowledge acquisition from key customers partially mediates effects of social capital on competitive advantage. Our study thus provides empirical support to the links between social capital, knowledge acquisition, and knowledge exploitation. By offering measures of key

constructs and by testing several dimensions of social capital and competitive advantage outcomes, we contribute to the empirical and theoretical development of this important stream of research on value creation.

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