SWIMMING WITH SHARKS:
TECHNOLOGY VENTURES AND CORPORATE RELATIONSHIPS

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ABSTRACT

This paper focuses on the tension that firms face between the need for resources from partners and the potentially damaging misappropriation of their own resources. Taking a unique entrepreneurial lens, we study this tension at tie formation in corporate investment relationships in 5 technology-based industries over a 25-year period. Central to our study is the "sharks" dilemma – i.e., when do entrepreneurs choose partners with high potential for misappropriation over less risky partners. Our findings extend resource dependence theory in terms of multiple resources and contribute the uncertainty logic of resource misappropriation to the theory. They also offer novel insights about resource mobilization including the unique defense mechanisms (i.e., secrecy and timing) and surprising power of entrepreneurial firms.

A central question in organization and strategy research asks: How do firms gain resources (Penrose, 1959; Thompson, 1967). In response, research identifies several approaches including acquisition of other firms (Larsson and Finkelstein, 1999) and organic development (Katila, 2002). But acquisitions can be too expensive or unavailable (Graebner and Eisenhardt, 2004), and organic development can be too slow (Eisenhardt and Tabrizi, 1995). When this occurs, inter-organizational relationships are an attractive way to obtain resources, especially for entrepreneurial firms that must quickly mobilize a variety of resources.

When firms consider forming inter-organizational relationships, they face a fundamental tension. On the one hand, they are pushed toward forming relationships by their dependence on others for needed resources (Pfeffer and Salancik, 1978; Gulati, 1995b; Zaheer et al., 1998). On the other hand, they are also pulled away from relationships by concerns about possibly damaging misappropriation of their own resources by their partners (Gulati and Singh, 1998; Ahuja, 2000a; Katila and Mang, 2003). Although this tension between these cooperative and competitive views of ties can occur throughout relationships (e.g., Brandenburger and Nalebuff, 1996), it is particularly influential at tie formation (Das and Teng, 2000). When firms are forming ties, they have the greatest flexibility to choose among potential partners, or simply avoid ties with too much potential for misappropriation or too little resource value. So, the tension between resource needs and the potential misappropriation of resources is highly relevant at tie formation, and is likely to be a primary determinant of whether firms choose to form ties at all.

Prior research confirms that firms are pushed to form ties by needs for resources. Building on exchange theory (Emerson, 1962), resource dependence researchers argue and find that dependence on others for resources leads firms to seek ties (Pfeffer and Salancik, 1978). Network researchers complement resource dependence by indicating with whom ties form. For example, they emphasize that direct and indirect ties provide information about potential partners and partnership opportunities, and so enhance the likelihood that firms will prefer to form ties locally (Gulati and Gargiulo, 1999).

In contrast, prior research has been less engaged with possible misappropriation of resources in relationship formation. As noted above, resource dependence scholars focus on the dependence that pushes

firms to form ties (Pfeffer and Salancik, 1978), not on potential misappropriation that pulls them away. Network scholars implicitly address potential misappropriation by arguing that firms are more likely to form ties with embedded partners whom they already know and so whose reliability is confirmed (Gulati, 1995b; Chung et al., 2000). But they do not directly address misappropriation in situations when no local partner has the needed resources, local partners are themselves unreliable, or partners with the highest potential for misappropriation also have the best resources. Since transaction cost scholars focus on the efficient governance of existing ties, they specify the most efficient governance mechanisms to protect against potential misappropriation *during* tie execution (Mowery et al., 1996; Dyer et al., 2005; Mayer and Salomon, 2006). But since the theory takes ties as given, TCE scholars neglect the decision calculus by which firms form ties in the first place. Overall, the influence of potential misappropriation of resources on tie formation is critical yet under-studied.

A particularly appropriate setting to study the tension at tie formation between resource needs and potential misappropriation is the entrepreneur's decision to enter a corporate investment relationship[i]. This choice is appropriate for several reasons. First, the tension between resource dependence and misalignment is highly acute in this choice. Given that new firms usually must make investments in advance of profits, they often require extensive financial resources from outside the firm. In addition, they often have too few operational resources. At the same time, established firms often have excess operational resources, including manufacturing or sales capacity that they cannot fully utilize (Penrose, 1959; Dushnitsky and Lenox, 2005b), and significant financial resources. Thus, new firms often are pushed towards corporate investment relationships. Yet, corporate investment relationships may also involve potential misappropriation concerns that push new firms away from these relationships. These concerns may include revealing the venture's key resources such as technologies and other intellectual property in ways that are counter to the strategic interests of the new firm (Doz, 1988). Moreover, this potential misappropriation is especially critical for new firms because their intellectual property is more easily appropriated than the resources of established firms such as manufacturing facilities, and because equity relationships typically

lock the venture into the tie until a liquidity event. In addition, although established firms rely on defenses during relationships (Pisano, 1990), new firms are less able to defend themselves once ties form. They typically have limited managerial time and legal resources to defend themselves against opportunistic actions in ongoing ties. So they are likely to anticipate potential misappropriation of their resources when they consider tie formation. Thus, when new firms consider whether to enter a corporate investment relationship, they often face the tension between resource dependencies that pull them toward relationships and misappropriation concerns that push them away.

Second, corporate relationships are intriguing because new firms may have a choice among viable alternative types of partners. For instance, they may be able to form ties with other types of partners (e.g., venture capitalists) that may have less risk of resource misappropriation (Sahlman, 1990). While not all new firms have these alternatives, those new firms that are of interest to corporations as investments are also likely to be of interest to other types of partners.[ii] And yet research neglects the intriguing dilemma of whether to form ties with partners that have the most needed resources but also the highest potential for misappropriation (i.e., "swim with sharks") over less risky partners with less critical resources.

Third, corporate investment relationships are also intriguing because of their practical import. About 25% of entrepreneurial firms with professional investments, including about 50% of technology-based ones (Rosenberger, 2005), have one or more corporate investment relationships. They are also a source of insights into new technologies, and so complement R&D activities within corporations (e.g., Dushnitsky and Lenox, 2005a; Basu et al., 2006).

Our purpose is to explore when firms form inter-organizational relationships. Specifically, we ask: *When do new firms form corporate investment relationships*? To address this question, we analyze fundraising round data for 701 ventures in 5 technology-intensive industries from 1979 to 2003. Thus, we sample firms that are open and able to gain professional investment ties, and then examine when they choose established firms over less risky professional investors, the choice at the core of our study. We supplement our data with fieldwork including interviews with entrepreneurs, corporate investors and

venture capitalists to deepen our understanding of the phenomenon. Using these data – that substantively expand the scope and detail of empirical studies on corporate investment relationships – we examine a fundamental tension that firms face when they decide to form ties.

We have two core contributions. The first is *adding potential misappropriation of resources at the pivotal time of tie formation* to complement resource needs. This contributes to the nascent renaissance of resource dependence theory (c.f., Casciaro and Piskorski, 2005; Gulati and Sytch, 2007) by arguing and testing several competitive, cooperative, and bilateral extensions of the theory. Of particular note is what we term the "*sharks dilemma"* – i.e., whether to select partners with uniquely attractive resources but also substantial risks over safer but less well-endowed partners. The second is novel, counter-intuitive findings about how entrepreneurial firms mobilize resources. By uniquely taking the entrepreneur's perspective on corporate investment relationships, we observe the particular importance of the tie formation stage for entrepreneurs in defending their resources. We especially highlight their distinctive *defense mechanisms* (i.e., *secrecy and timing)* that differ from the traditional mechanisms of established firms that focus on post-formation defense. We also challenge two pieces of conventional wisdom: ventures as weak, passive decision makers and an overly rosy view of corporate ties for entrepreneurs. That is, extant research may over-state the benefits of ties with established firms, and under-state the power of new firms.

THEORETICAL BACKGROUND

Two primary research streams relate to our research question. One focuses broadly on inter-organizational relationship formation, while the other focuses narrowly on venture financing relationships. Here, the contrast between venture capital and corporate investors is especially relevant.

Formation of Inter-organizational Relationships

Resource dependence theory is the principal approach to studying when firms form inter-organizational relationships (Pfeffer and Nowak, 1976). The theory focuses on how firms garner needed resources from the environment, and so reduce uncertainty (Scott, 2002). Some research looks explicitly at forming ties between new and established firms. Research that takes the *established firm* lens emphasizes

that these firms use relationships with new firms to exploit excess resources (Pisano, 1990), complement their existing inter-organizational relationships (Arora and Gambardella, 1990), and access new technologies (Mitchell and Singh, 1992; Steensma and Corley, 2000), but not typically to get access to operational resources (Pisano, 1990). More limited research takes the *new firm* lens. This work emphasizes that new firms use ties with established firms to obtain resources, especially when the new firm is in a rapidly growing market (Shan, 1990; Eisenhardt and Schoonhoven, 1996). But this work is not specific regarding the specific resources. In addition, related research on the performance implications of these ties strongly emphasizes the positive outcomes for new firms (Stuart et al., 1999; Baum et al., 2000; Gulati and Higgins, 2003). But this work neglects the potentially negative outcomes that we address.

While useful, this research suggests several research gaps. First, a key omission is studies that address the tension between resource dependencies and potentially damaging misappropriation of resources at the pivotal time of tie formation. Past research emphasizes resource dependencies at *formation* (Shan, 1990; Ahuja, 2000b) and potential misappropriation during *execution* (Mowery et al., 1996), but misses how they simultaneously operate at tie formation. Second, research is imprecise about the nature of resources and neglects multiple types of resources (e.g., manufacturing, financial, and marketing) that may vary in importance. Finally, research ignores multiple types of partners, particularly ones with highly attractive resources *and* misappropriation risks that pose the dilemma of whether to "swim with sharks". In sum, there is an opportunity for a study such as ours that focuses on the perspective of new firms, and extends resource dependence theory by adding competitive considerations and enhanced precision regarding resources at tie formation.

Venture Financing Relationships

Venture capital investment. A second research stream on venture financing relationships is also relevant to our research. Within this stream, the spotlight is on the *venture capitalist* (VC) perspective on investment relationships with new firms. Research identifies the resources that VCs both contribute and gain from these relationships, and their goals that are well-aligned with the venture's. In particular, VCs

typically contribute financial resources, legitimacy, advice, referrals to executive hires, and industry connections (Sapienza, 1992). They typically align their incentives with entrepreneurs (Bitler et al., 2005), contract out agency risks via term sheets[iii] (Kaplan and Stromberg, 2004), and monitor investments through board seats (Gompers, 1995). Such forms of hierarchical control and board representation "create a forum in which both partners exchange information and can initiate and ratify decisions on a regular basis" (Gulati and Singh, 1998: 793), and thus mitigate possible misalignment, including potentially damaging misappropriation of resources. Finally, since VCs seek a financial return that is related to venture success, their likelihood of misappropriating the resources of new firms is reasonably low.

Other research takes the *new firm* perspective on VC investment relationships. The findings indicate that ventures enter relationships with VCs to obtain new partners, gain introductions to possible executive team members, and obtain help in formulating strategy (Smith, 1999). The findings also show that VC investment relationships are advantageous to new firms. For example, new firms with investment relationships with VCs (especially prominent ones) grow faster, have better reputations, gain more introductions to potential alliance partners, and are more likely to reach IPO (Stuart et al., 1999; Davila et al., 2003; Beckman, Burton, and O'Reilly, 2007). Overall, these studies reveal that the resources provided by VCs fit those needed by entrepreneurs, and, more significant for this study, that the goals of VCs are relatively well- aligned with venture success and that their likelihood of misappropriating the resources is fairly low.

Corporate investment. Recent research looks at investment relationships in new firms when the investor is a corporation. This work takes the *corporate perspective* by studying relationship formation as the corporate partner's decision (Chesbrough and Tucci, 2003; Benson and Ziedonis, 2005; Dushnitsky and Lenox, 2005a; Wadhwa and Kotha, 2006). The rationale is that the corporation is the dominant partner in the relationship, and so has the choice of whether, how much, and in whom to invest.

This literature contrasts with the VC investment literature by highlighting the significant role of the non-financial (i.e., strategic) interests of corporations in relationships with new firms. Corporations

are not just buying a piece of the new firm in a financial transaction, but rather are exchanging their own resources for access to promising new technologies that may speed their own technology development, provide information on possible acquisitions, and even block new products that might compete with their own (Helft, 2006; Wadhwa and Kotha, 2006; Hoyem and Huston, 2007). In particular, investment in new firms is usually a complement to, and sometimes a substitute for, the corporation's own R&D (Mason and Rohner, 2002). Consistent with this view, a corporate interviewee[iv] noted that venture investments provided an "*early view on strategically relevant growth companies"*. Others were more specific. A chemical firm executive described, *"Investment in [a startup] gives us a unique window on how this emerging field is developing as well as enables us to influence its activities in directions that are of interest to us far beyond what is afforded us in typical R&D contracts."* An investment manager from another firm shared, "*Corporate venture activities are an extension of innovation in the organization*." Consistent with this view, research indicates that established firms are more likely to enter an investment relationship with a new firm (and benefit from it) when they can easily absorb technology – i.e., when their technology is related to that of the venture (Gompers and Lerner, 2002), the venture's technology is novel and significant (Stuart, 2000), and the patent regime of the venture's industry is weak (Dushnitsky and Lenox, 2005b). They also tend to invest in industries where technology opportunities are plentiful and to accept lower valuations (Gompers and Lerner, 2002). An informant from a corporate venture arm summarized, "*Big companies are simply not very good at innovation…or realize that in some markets innovation needs to come from external sources*" (see also Anderson and Tushman, 1990; Bowen et al., 1994; Utterback, 1994; Katila, 2002). The key point is that, from the corporate perspective, investment relationships with new firms are strategic, not just (or even primarily) financial transactions.

Corporate investors are also less likely to be well-aligned with the interests of new firms than are VCs. For example, unlike VCs, many corporate investors do not take a board seat as part of the investment relationship (Broderick, 2005), and so opportunities to use hierarchical controls to align the interests of the new and established firms are more limited. Indeed, our interviews with corporate

investors indicate that they often prefer *not* to have a board seat in order to avoid a conflict between their corporate strategic interests and fiduciary responsibilities to the new firm. By remaining off the board, they can more readily pursue their corporate interests. As a former head of Sun's venture arm said, "*the interests of a corporation and a venture are seldom, if ever, aligned*". The key point is that corporate investors are less-aligned with new firm success than VCs and more likely to misappropriate resources.

In contrast, there is no research (that we know) that takes the *new firm perspective* on corporate investment relationships. Rather, the corporation is viewed as the powerful, resource-rich and highly desirable partner (e.g., Stuart et al., 1999; Maula et al., 2003) that dominates the decision to form an investment relationship, while the new firm is the resource-poor, passive target that is highly motivated to enter these relationships by enhanced prestige and access to corporate resources.

Yet, this one-sided view is probably incomplete. Indeed, several observations suggest that young firms are active decision makers too. First, recent findings show that corporate investors are not as powerful as might be anticipated. They sometimes fail to get their first choice investment (Gompers, 2002), and cannot make the acquisitions they prefer (Graebner and Eisenhardt, 2004). Our interviews echo this view. For example, a telecom corporate investor saw venture investing as a marketing effort, not her unilateral choice. She outlined the '*value proposition*' that she used to woo ventures, "*We work with 180 carriers day in and day out. It is unusual to find a [venture] sales director that has that kind of Rolodex to get into the market quickly. A [venture] CEO will look at us and say, 'big name, strong balance sheet, can help me get into customers quicker'*." Also while corporate investors may have many possible relationships, they typically want ties with the most desirable (e.g. best resources) new firms. Yet these new firms are precisely the ones that are likely to be of interest to other investors. For example, another corporate investor described how his firm competed for ties by trying to lower the risks for ventures, "*What we try to do structurally is make sure our term sheets are very vanilla and that we don't look for any unusual M&A rights or rights of information… We are also very open to having [another corporate investor] as one of the co-investors with us to make sure it doesn't seem like just [our] vehicle. That is very comforting for them [the entrepreneur]. We are very*

upfront. We don't look for exclusivity….That really puts them at ease. It is key for them to hear that." Finally, corporations are more likely to pay too much by investing in overvalued transactions relative to other investors (Gompers and Lerner, 2002), and pay too much if they subsequently acquire the venture (Benson and Ziedonis, 2005). Importantly, these findings indicate, that while important, corporations are not the only relevant actors in the decision to form corporate investment relationships.

Second, while in-depth field studies of venture fundraising indicate a complex process (Zott and Huy, 2007), they also show that entrepreneurs are active participants (along with their existing angel and VC investors) including involvement in when to raise money, how much to raise, and whom to approach (e.g., Tyebjee and Bruno, 1986; Dorf and Byers, 2005). For example, a software venture executive described his strategy for including a corporate investor, "*What we needed was at least one good brand name. We also looked at it from a new angle, which was to raise corporate money. We wanted a mix of people who would be useful from a business perspective.*" Another entrepreneur noted his thought process for assembling investment partners, "*I think it is exactly like when you are weighing multiple job offers. It is a complex model, and one piece of it is how much money are they going to put in for what percentage of the company. Other pieces include: How will they [corporate investors] get along with other investors that you might bring along down the road? And how have they behaved with other entrepreneurs in companies?*" Our interviews also reveal that entrepreneurs (often with their principal investors) choose among potential corporate partners. One entrepreneur described purposefully orchestrating the process, and courting some corporations while rejecting others. As she noted, "*Fundraising was about limiting the amount of people involved, but getting the right people involved [i.e. most appropriate corporate investors]. There were some that we had to convince to come on, and others we had to limit.*" Entrepreneurs also often determine, usually with their VCs, whether a corporation is able to invest at all. As another entrepreneur noted, "*We got a huge deal done with [Blue Chip Corporation] where they got to re-market our product…That was really key to us. But we didn't give them a board seat, and we didn't let them invest.*" The key point is that entrepreneurs are active decision makers in their fundraising process, thereby making the entrepreneurial lens important to when new firms form corporate investment ties.

Finally, our interviews indicate that entrepreneurs understand the non-financial and strategic interests of corporate partners, and are aware of the potential for misappropriation. As one entrepreneur described, "*Strategics [common term for corporate investors] don't care about valuation. That's not their motivation. They're in it for other reasons like access to the technology, market manipulation, or a jump on competitors*". Another software entrepreneur noted, "*So I'm a proponent of strategic partners and customers as investors but I'd prefer to keep them in an advisory or observer role so you can still have closed board meetings. I just don't think their interests are with you 100%* ". The key point is that entrepreneurs often recognize corporate motives surrounding resources and anticipate the potential for misappropriation in their relationships. Overall, these observations suggest that the new firm lens on corporate investment relationships is understated, understudied, and useful for studying our core theoretical interests.

HYPOTHESES

We develop two sets of hypotheses to explain when new firms form corporate investment relationships. One set uses arguments from resource dependence theory to develop hypotheses about the resource needs that push young firms into these relationships. The second relies on arguments that extend resource dependence to defense mechanisms that entrepreneurs can use to mitigate potential misappropriation of resources. We also develop hypotheses that reflect the bilateral nature of ties, and integrate the cooperative (resource needs) and competitive (defense mechanisms) views of ties.

Resource Needs

Financial resources. Resource dependence theorists studying inter-organizational relationships argue that firms facing uncertainty about accessing resources are likely to form ties with firms that possess the needed resources (Pfeffer and Nowak, 1976; Gulati, 2007; Eisenhardt and Schoonhoven, 1996). In our context, a key task for entrepreneurs is to mobilize financial resources so that the venture can prosper. When the costs of technology development or sales are high, the financial resource needs of new firms may outstrip the funding capabilities of many types of investors. This is often true when entrepreneurs are funded by angel investors who have limited capital and VC firms who limit their total investment in each

venture to meet portfolio goals and maximize their overall financial return[v] (Gupta and Sapienza, 1992). In these situations, forming investment relationships with established firms can be attractive. These firms are especially rich sources of capital because they often do not face the external portfolio pressures that VCs do, and can therefore provide outsized cash infusions from a single source, without the venture having to court and coordinate a large syndicate of investors.

Hypothesis 1. Entrepreneurs with greater financial resource needs will be more likely to form an investment relationship with a corporation.

Complementary resources. The second resource argument focuses on the new firm's need for operational resources that established firms often possess, and other types of investors seldom provide. New firms rarely own all of the resources that are necessary for the development and commercialization of their products (Teece, 1986). For example, Santos and Eisenhardt (2004) studied a venture that allowed five established firms to invest in order to gain access to their operational assets. This approach was successful, and several corporate partners provided key marketing and distribution resources. This example suggests that new firms that need complementary resources (e.g., manufacturing, sales force, and branding) can potentially use funding relationships to harness such resources from investing corporations. Thus, we argue that entrepreneurs will be more likely to pursue corporate relationships when complementary resources are more necessary to develop and commercialize products in the industry where they operate.

Hypothesis 2. Entrepreneurs with greater complementary resource needs (i.e., manufacturing and marketing) will be more likely to form an investment relationship with a corporation.

Resource hierarchy. While the prior hypotheses addressed financial and complementary resource needs from the new firm's lens, relationship formation is bilateral such that the interests of both parties are germane to tie formation (Emerson, 1962; Pfeffer and Salancik, 1978). Corporate investors are likely to be especially interested in relationships that involve complementary resources because excess operational resources can be a rationale for an established firm's interest in an investment relationship (Penrose, 1959). More important, since corporate investors usually have a strong strategic interest in the young firm's technology (Mason and Rohner, 2002; Wadhwa and Kotha, 2006), they may be particularly keen to

provide complementary resources. Providing complementary resources may enable the corporate partner to gain access to new firm resources or influence its technology development because of the coordination demands that using these resources has. Manufacturing resources may be particularly appealing to corporations because product development decisions are often intertwined with manufacturing choices at the design stage (Utterback, 1994; Wasti and Liker, 1999), and further insights into technology are often revealed during manufacturing (Pisano, 1989). New firms may also prefer relationships when they need manufacturing resources (over marketing ones) because manufacturing resources are often especially expensive and slow to create, important to operational success, and uniquely available from corporations. In contrast, marketing resources are often easily available in non-equity relationships such as revenue-sharing agreements that enable new firms to gain resources without diluting ownership. In contrast, although financial resources are highly attractive to new firms because of their fungibility, simply providing financial resources may be less appealing to established firms because they offer little opportunity to gain insight into the new firm's resources, especially intellectual property. Thus, complementary resource needs (especially for manufacturing) are more likely to propel relationship formation than needs for financial resources. Incorporating the corporate view suggests the following ordering of resource importance:

Hypothesis 3. There is a resource hierarchy where entrepreneurs with complementary resource needs (manufacturing, then marketing) will be more likely to form an investment relationship with a corporation than entrepreneurs with financial resource needs.

Defense Mechanisms

Patent defense. Resource dependence theorists have developed theory that accounts for resource needs (Pfeffer and Salancik, 1978). Yet as we will argue, the theory can be extended to potential misappropriation. Specifically, we argue that, while firms *decrease* uncertainty surrounding access to needed resources by forming ties with firms that possess those resources (Pfeffer and Salancik, 1978), these ties can also *increase* uncertainty if the resources are gained from partners possibly inclined toward unwanted resource appropriation. As Pfeffer (1982) notes, dependence occurs when one partner needs the

resources of the other, and cannot easily gain these resources elsewhere. So if misappropriation of new firm resources is successful, it allows established firm partners to gain some control over the focal firm's resources, and ultimately lessen their dependence and diminish the focal firm's power. Thus, misappropriation adds a new source of uncertainty for new firms when ties are formed. Since defense mechanisms mitigate this uncertainty and so help the focal firm to maintain its power in the relationship, firms are more likely to form ties with partners who might potentially misappropriate their resources when defense mechanisms are available. That is, since firms can usually anticipate the potential for misappropriation, they are likely to avoid these relationships when they have weak defenses.

In our context, new firms are at a particular risk of losing their technology resources because the established firm's primary motivation for the relationship is typically strategic interest in the new firm's technology (Basu et al., 2006). This risk is most acute when investing firms can easily capture the financial benefits of the new firm's technology.[vi] For example, there can be subtle pressure on the new firm to pursue a technology agenda that is favorable to the established firm. Several of our interviewees described corporate investors that influenced a venture's product resources. A corporate investor noted, "*Our corporate venture unit has definitely given us leverage in negotiating contracts with the startups we have invested in, as well as having input into product development*." Since new firms are likely to be aware of attempts to access and control their technology resources, they are likely to enter corporate investment relationships when defense mechanisms are available to mitigate this uncertainty.

Although new firms usually cannot rely on some common defense mechanisms to protect their intellectual property such as economies of scale and complementary assets because of their small size and limited resources (Teece, 1986), they can use two common legal instruments to protect their inventions: patents and trade secrets (Katila and Mang, 2003; Anton and Yao, 2004). These instruments can be used independently or simultaneously to protect different parts of the same invention (Cohen et al., 2000). In the case of patents, a patent gives the holder the right to exclude others from the use of the invention covered by the patent (Walker, 1995). Patents allow the holder to prosecute others who infringe, regardless of the

source of the infringers' ideas, and so are an effective means (or at a minimum, delay infringement) of protecting some parts of the venture's product invention against misaligned corporate interests. However, the strength of patent protection varies across industries. Thus, we propose that new firms prefer corporate investment relationships when the patent regime in the venture's industry is strong (rather than when it is weak), because of enhanced ability to defend against the competitive aspects of the relationship.

Hypothesis 4a. Entrepreneurs with inventions that are more strongly protected by patents will be more likely to form an investment relationship with a corporation.

Secrecy defense. Although patents provide protection against a broad range of appropriation behaviors, the threshold for receiving a patent is high, requiring novelty, utility and non-obviousness of the invention (Walker, 1995). In contrast, a second legal instrument, trade secrets, offers an exclusive source of protection to a diverse range of intellectual property from know-how to recipes to customer lists, as long as the firm keeps them secret (Epstein, 2004). Both the use of improper means to discover trade secrets and the use of improperly discovered trade secrets are illegal, making trade secrets an effective means of protecting intellectual property. Nondisclosure agreements, material transfer agreements and non-compete clauses that may mitigate the risk that the corporation will hire the venture's employees or otherwise transfer intellectual property are commonly used to protect trade secrets (Scotchmer, 2004). However, the strength of trade secret protection varies across industries. Thus, we propose that entrepreneurs are better able to protect their technical inventions, and so more likely to enter into corporate investment relationships the stronger the trade secret regime in the venture's industry.

Hypothesis 4b. Entrepreneurs with inventions that are more strongly protected by secrecy will be more likely to form an investment relationship with a corporation.

Timing defense. While legal defense mechanisms such as patents and trade secrets may be useful to protect specific inventions, new firms may also protect their technology resources and themselves more broadly through timing. Later timing is likely to make it more difficult for a partner to appropriate intellectual property (Lerner and Merges, 1998) because it is easier to protect a more mature technology that is more fully embodied in a product from possible appropriation (Dorf and Byers, 2005). For example,

biotech entrepreneurs use this reasoning when they delay R&D collaborations with unfamiliar partners (Katila and Mang, 2003). Although Katila and Mang focus on R&D collaborations in a particular industry, it seems likely that entrepreneurs in other industries and pursuing other types of collaborations may also use timing as a defense mechanism. Also later timing makes it more difficult for established firms to influence the product portfolios and strategic agendas of new firms because their products and strategies will be more well-developed, robust, and visible (Sahlman, 1990; Rivkin, 2000). Indeed, several VCs told us that they actively discourage new firms from entering corporate investment relationships when the new firm is immature because it is especially vulnerable to corporate influence. As one said, "*Some ventures may naively believe that corporations provide debt financing. They really don't. A venture needs to be strong enough, independent enough, before it takes a corporate investor. Or else the venture becomes a development arm for the corporation.*" Similarly, an entrepreneur noted, "*I don't think you want to have strategics [corporate investors] as the main people initially because then you'll just have too many people steering the bus*". In particular, we argue that new firms are more likely to pursue corporate investment relationships in later funding rounds when the firm's technologies, products and strategic agendas are more mature[vii] and so more defensible. In addition, later timing is also an effective defense mechanism because better-aligned investors such as VCs typically are present from prior rounds to help thwart competitive actions by corporate investors. Thus, we propose:

Hypothesis 5. Entrepreneurs protected by later timing will be more likely to form an investment relationship with a corporation.

Defense hierarchy. While the prior hypotheses address defense mechanisms from the new firm lens, relationship formation is also influenced by corporate preferences. Established firms may be deterred by strong legal protection such as patents because it limits access to the new firm's technology. For example, research shows that corporations prefer ties to ventures with weak patent regimes because this gives easier access to the venture's technology (Dushnitsky and Lenox, 2005a). Thus, while patent protection may be in the interests of the venture, it may repel the potential corporate partners. In contrast,

corporations may be less deterred by trade secrets because they are a weaker protection mechanism than patents (Scotchmer, 2004). Finally, both parties may prefer timing as a defense mechanism. Established firms may prefer to form relationships later when the quality of the venture and its resources are clearer, and so uncertainty is reduced. They are also less likely to tie up their operational resources and waste their financial resources on a low-quality new firm. New firms may prefer timing as a defense mechanism because it has few (if any) legal costs, and is more broadly applicable than legal defense mechanisms that focus on specific inventions. Adding the corporate view suggests the following ordering:

Hypothesis 6. There is a defense mechanism hierarchy where entrepreneurs protected by later timing will be more likely to form an investment relationship with a corporation than entrepreneurs protected by intellectual property defense mechanisms (trade secrets then patents).

Integrating Resource Needs and Defense Mechanisms

As argued earlier, the cooperative push of resource needs vs. competitive pull of potential misappropriation pose a fundamental tension for both parties. While it is clearly desirable for new firms to access needed resources from their partners while also maintaining high protective defenses for their own resources, this is less desirable from the partner view (and vice versa). Thus, we propose that new firms are more likely to enter corporate relationships when the preferences of the two firms are reinforcing – i.e., when there are mutually desirable resources and mutually desirable defenses. This logic recognizes that tie formation is an integrative negotiation of both firms' preferences. Similarly, we propose that, when there is asymmetry such that one partner is likely to receive (or lose) more than the other, a tie is less likely.

Hypothesis 7. Entrepreneurs that simultaneously integrate the opposing forces of competition and cooperation will be more likely to form an investment relationship with a corporation.

METHODS

Sample and Data Sources

We analyzed the choice to form corporate investment relationships by new firms over a 25-year period from 1979 to 2003. The sample of new firms was drawn from the population of U.S. investor-backed technology ventures that received their first venture funding between 1979 and 1995. We chose

investor-backed ventures because their ability to attract external funding indicates viable technology and marketing agendas, and thus a choice of investors (Hellman and Puri, 2000; Davila et al., 2003). We chose technology ventures because of their substantial needs for financial and complementary resources, and their intellectual property that is likely to exacerbate risks for misalignment and the related tension that is a focus in this study. We analyzed data on these ventures by funding round from 1979 to 2003.

We began the sample in 1979 when the U.S. Department of Labor clarified the "prudent man" stipulation in the Employment Retirement Income Security Act to allow pension fund managers to invest in VC funds (Gompers and Lerner, 2001). This policy change dramatically increased the supply of venture funding in the ensuing years (Bygrave and Timmons, 1992). We concluded sample selection with the firms founded in 1995, but continued data collection for all firms until 2003. Because a venture typically takes five to seven years to experience a liquidation event after the first investment round (Fenn et al., 1997), stopping with firms founded in 1995 enabled us to follow most sample firms through all funding rounds, and so gain a more complete picture of their actions.

Our unit of analysis is the funding round. Entrepreneurs form investment relationships at discrete points in time (termed funding rounds) because investors typically stage their financing of ventures into rounds that track venture progress and so limit the risks associated with such investments (Sahlman, 1990; Podolny, 2001) while entrepreneurs use discrete funding rounds to match investor timing and limit distractions from running their firms (Graebner and Eisenhardt, 2004). Data were collected for each venture's funding rounds through 2003, or until a liquidation event (e.g., IPO, acquisition).

Our primary source of data is Venture Economics. This database provides detailed information about ventures, firms investing in these ventures, and funding rounds. Venture Economics is a particularly appropriate choice for several reasons. First, it is used extensively in prior research, and has been shown to provide an accurate and comprehensive description of venture financing (Lerner, 1995). Various studies (e.g., Kaplan et al., 2002) and our own analysis further show that Venture Economics does not over-sample ventures that subsequently go public (eliminating a concern for success bias) and that the data are

representative of the U.S. ventures that receive funding from professional investors. Second, Venture Economics was launched in 1969, and so enables a study of an unusually long time period, 1979 –2003, thus achieving more robust results. Third, firms in Venture Economics receive funding from external investors, and so are likely to have innovative technologies (Hellman and Puri, 2000) and, even more significant for our study, a choice among types of investor-partners.

We triangulated Venture Economics with data from VentureOne and Lexis-Nexis in order to develop a comprehensive and accurate database. The three databases rely on distinct, yet complementary, data sources. That is, investors provide Venture Economics data, entrepreneurs are the source of VentureOne data, and archived corporate press releases and media coverage are the source of Lexis-Nexis data[viii]. By using these complementary sources, we use multiple informants for the same events, and so increase the completeness and accuracy of our data. For example, while investors are sometimes coded as "undisclosed" in Venture Economics, we identified them in VentureOne or Lexis-Nexis.[ix]

Our data collection proceeded as follows. We began by forming the sample from Venture Economics data. We then corroborated the information, and identified missing investor and other information with data from VentureOne. Finally, if there were still missing or inconsistent information (e.g., undisclosed investors), we examined news articles and press releases in Lexis-Nexis to identify them. As an additional check, we repeated the statistical analyses of our hypotheses using only data from Venture Economics, and then only data from VentureOne. Both sets of results were strongly consistent with our reported findings from the combined database. Overall, this coding effort of multiple data sources added information to roughly 20% of the rounds. As described later, we further supplemented these data with information from other sources (e.g., SDC, Compustat and Hoover's) in order to measure the independent variables and controls that are not captured in fundraising databases. The result is a uniquely refined and comprehensive data on corporate investment relationships in 5 industries over 25 years.

--- Insert Table 1 about here ---

Specifically, we drew a stratified random sample of 701 ventures from the population of

technology ventures that received their first funding in 1979-1995. We stratified the sample by year and by five broad industry groups as designated in Venture Economics: medical, biotechnology, communications, electronics, and software. These five industry groups represent the largest technology industries during the study period, and include over 80% of the technology ventures funded during this time. The sample size was chosen using standard statistical power calculations to capture small size effects (Cohen, 1988; Green, 1991) and the sample represents approximately 11% of the U.S. technology ventures funded during this time period. In all, these firms (approximately 140 within each industry) raised 18,168 investments in 4,077 funding rounds, our unit of analysis, between 1979 and 2003. Examples of ventures and corporate investors in our sample are included in table 1.

Measures

The primary dependent variable is the *likelihood that a new firm forms an investment relationship with an established firm (corporate venture investment)* in a round. It is a binary variable that equals one if a new firm receives a corporate investment in a funding round and equals zero if it does not. Both U.S. and foreign corporate investments are captured, making our coverage more comprehensive than those studies that focus on U.S. investors only (e.g., Dushnitsky and Lenox, 2005a,b). Investment partners are coded as corporate if they provide equity (we excluded loans and public offerings) and are non-financial firms. This definition of corporate investors excludes subsidiaries of banks and insurance companies, for example, in order to focus on corporations with non-financial and potentially misaligned strategic interests.

We coded over 1,200 corporate investments. We used company directories, annual reports, and databases on public companies such Compustat and Worldscope to identify the investors and the industries in which they operated. Two authors independently coded the data with the help of a computer program that matched inconsistent spellings and repeat investments. We also create two related dependent variable measures: the *number of corporate venture investors* and the *hazard rate to first corporate investor*.

Resource needs variables. We constructed measures for the independent variables including three measures for the resource needs. We measured the new firm's *financial resource need* by the funding

round amount in thousands of U.S. dollars. Round amount is an effective measure of the amount of capital needed because entrepreneurs determine the size of a funding round by trading off their capital requirements against unnecessary ownership dilution from raising excessive funding (Gompers and Sahlman, 2002). This tension keeps entrepreneurs from raising less funding than they need and risking the viability of the new firm, and raising more than they need and rendering too much ownership to investors. We used the producer price index (PPI) to adjust round amount for inflation and then logged it to mitigate skewness. We also computed an alternative measure: deviation of the financial resource need from the industry-mean for the round. The results we present later also hold for this alternative measure.

We measured *complementary resource need* by those operational resources that new firms often do not have, but require to be viable. Since the need for specific complementary resources is associated closely with participation in specific industries (Arora and Gambardella, 1990; Katila and Shane, 2005) and this type of firm-level data is extremely difficult (perhaps impossible) to collect in a multi-industry and multi-decade study such as ours, we measured this variable at the granular 4-digit Standard Industrial Classification (SIC) code level. We also used alternative measures from a different source, noted below.

In our first set of measures, we identified two primary types of complementary resources that are frequently discussed in the literature: manufacturing and marketing (Geletkanycz and Hambrick, 1997; Gulati and Westphal, 1999). We measured *manufacturing resource need* by the capital intensity of the industry because new firms in highly capital-intensive industries are likely to require greater manufacturing assets to commercialize their products. Our measure of capital intensity was the average ratio of fixed assets to sales in each industry yearly. We measured *marketing resource need* by the advertising intensity of each industry because if the advertising intensity in the industry is high, product commercialization is likely to be marketing-intensive and require the joint exploitation of marketing resources and new technology. Our measure of advertising intensity was the average ratio of advertising expenditures to sales in each industry yearly. We collected these data from Compustat at the 4-digit SIC level.

In order to determine the industry for the above measures, we identified a primary SIC code for

each new firm. While Venture Economics assigns a broad industry classification for each new firm, it does not assign the more precise SIC codes that we use. Consequently, we collected SIC codes for each venture from Disclosure, Standard & Poor's and Hoover's databases. When we were unable to locate a pre-assigned SIC code for a venture in any of these three databases, we mapped the venture's business description in Venture Economics and the industry classification that Venture Economics assigns to each venture to four-digit SIC codes following a matching procedure documented in Dushnitsky and Lenox (2005a). In total, our sample ventures operate in 64 different four-digit SIC categories.

We also compiled alternative measures for complementary resource needs using alliance intensity data from the Securities Data Company (SDC). Alliance intensity is an excellent alternative measure because it reflects how likely the firms in an industry are to gain marketing or manufacturing resources from alliance partners. To construct the measures, we collected yearly alliance data for each four-digit SIC industry, and created two alternative measures: *manufacturing alliance intensity* (number of manufacturing alliances/net sales in each industry yearly) and *marketing alliance intensity* (number of marketing alliances/net sales in each industry yearly). Since the SDC alliance data are only available from the year 1987 onward, we had to limit this robustness check to a smaller subsample. Despite the smaller sample, the results we present later also hold for these alternative measures of resource needs.

Defense-mechanism variables. We measured *patent defense* and *secrecy defense* using the Carnegie Mellon Survey of industrial R&D (Cohen et al., 2000). The respondents (randomly selected R&D managers stratified by industry) estimated the effectiveness of defense mechanisms to protect technical inventions from imitation in their industry. Although the survey data are time-invariant, the source is robust because the efficacy of particular defense mechanisms against appropriability within industries is stable (Gulati and Singh, 1998). Further, the collection date (1994) is at the approximate midpoint of our time range (1979-2003). Finally, the Carnegie survey has been used extensively in research (e.g., Gulati and Singh, 1998; Shane, 2002; Arora and Ceccagnoli, 2006), and is considered the primary source of comparative data on appropriability. Our measure of *patent defense* is the percentage of

product inventions for which patents are considered an effective protection mechanism in a particular industry. Our measure of *secrecy defense* is the percentage of product inventions for which trade secrets are considered an effective protection mechanism in a particular industry. Since the Carnegie data are measured at the three-digit SIC level, we used three-digit values of patent defense and secrecy defense for the corresponding four-digit sublevels that we developed for each venture.

We measured the third mechanism, *timing defense,* by the investment round (e.g., first, second etc.) and logged this variable to reduce skewness. We argued that it is easier for entrepreneurs to protect a more developed technology that is embodied in a product, and for which technical and strategic agendas are established. Consequently, investment round is an appropriate measure of timing defense because it reflects the venture's maturity (Sahlman, 1990), and because commercial and technical progress of the venture is the primary determinant of its ability to advance to the next round (Shane and Stuart, 2002). We also used an alternative measure, development stage (Gompers and Lerner, 2002), with similar results.

Controls. Since prior work suggests that inertial behavior influences tie formation (Schoonhoven and Romanelli, 2001), we control for it. Consistent with other inter-organizational relationship (Katila and Mang, 2003) studies, we include a time-variant variable for *cumulative corporate investments* and measure it by the number of prior corporate investment relationships formed by each new firm.

Since prior work also suggests that social embeddedness factors facilitate tie formation (Gulati, 1995a), we control for several of them. We control for whether the new firm was a spin-off of a corporation (*corporate background*), expecting that a spinoff with founders from an established firm is particularly likely to inherit connections and knowledge from its parent (Agarwal et al., 2004; Klepper and Sleeper, 2005; Beckman et al., 2007). We measure spin-off with a dummy variable set to one if the venture is a spinoff and zero otherwise. We also control for whether prominent VCs invested in the new firm, expecting that these VCs are more likely to be able to broker ties with established firms. That is, since prominent VCs have central network positions (Stuart et al., 1999), they are more likely to have prior connections to corporations (e.g., have prior deals together, have sold portfolio companies to them, or have

syndicate partners with such connections) than less prominent VCs. We measured *prominent VC affiliation* by an investing VC's centrality in venture capital syndication networks. More details of this measure are provided in the appendix. We also control for *regional entrepreneurial development* (henceforth shortened to *region)*. We measure region as the new firm's geographic location in an entrepreneurially dense and sophisticated region. Since research indicates that Boston and San Francisco outrank the other U.S. metropolitan regions in entrepreneurial development (Bygrave and Timmons, 1992; Gompers and Lerner, 2001), we measure region with a dummy variable that is coded as one if the new firm is located in Boston or San Francisco, and zero otherwise. The new firm's location (by zip code) was collected from Venture Economics (or if needed from VentureOne and Lexis-Nexis), and was time-variant. Following Saxenian (1999), we defined Boston to include Middlesex, Norfolk, Suffolk, and Essex counties and San Francisco to include San Francisco, Alameda, San Mateo, and Santa Clara counties.

Consistent with many studies, we control for *firm age.* We measure firm-age as the number of months between the date when the venture began operations and the date of the investment round, and log this variable. We collected these data from Venture Economics. We also collected *firm size* data (measured by number of employees yearly). Although employee data are available (from Corporate Technology Directory) only for about half of our firms, we did confirm our original results with this reduced database. But since firm size and age are highly correlated and missing size data substantially drop our sample size, we use firm age as the control.

Because availability of venture funding may vary across industries and time, and may influence the propensity to enter corporate investment relationships, we control for *availability of venture capital*. We measured the variable by the total annual inflation-adjusted investment by VC firms in each of our five industries (in hundreds of millions of U.S. dollars) as reported by Venture Economics. We also include variables for the broad industry segments where our sample firms operate to control for any other unobserved *industry effects*. We include controls for five segments—biotechnology, communications, software, electronics and medical—based on venture SIC codes. In alternate tests, we also used variables

based on the original Venture Economics categories. Our results held independent of the measure used.

Finally, we include controls for the year of the investment round to capture any *temporal effects* that might contribute to the likelihood of a corporate investment relationship such as year-to-year variations in the supply of capital beyond what we have directly controlled for. Temporal effects are incorporated using (unreported) dummy variables for the calendar years 1979-2003 (1995 is the omitted year).

Statistical Methods

We use logistic regression to test the likelihood that a young firm forms a corporate investment relationship in an investment round. We also use negative binomial regression to analyze whether the factors that predict the likelihood of entering a corporate investment relationship also predict the number of corporate investors that will be engaged in a funding round. In logistic and negative binomial regressions, the number of observations equals the total number of funding rounds in the sample.

To control for venture heterogeneity, we use the Generalized Estimating Equations (GEE) regression method. The GEE method accounts for autocorrelation that arises because each venture is measured repeatedly across multiple funding rounds (Liang et al., 1986). The standard errors that we report are derived from the Huber/White robust estimator of variance that is insensitive to the choice of the correlation structure in the GEE method. As a sensitivity test, we also ran a random effects estimation[x] which provided the same pattern of findings. We report the GEE results, since unlike the random effects estimator, the GEE method does not require the strong assumption that the unobserved venture-specific effects are uncorrelated with the regressors (Stata, 2003).

To further probe the hypotheses, we analyze the rate of first corporate venture investor, using a Cox event history model (Cox, 1972). The venture is placed in the risk set upon the date of its founding, and the first corporate venture funding is the hazard event (Allison, 1984). As in the logistic and negative binomial regressions, the unit of analysis is the venture funding round. Unlike in the other two models, the venture leaves the risk set upon receiving its first corporate investment. Thus, Cox regression allows us to

isolate the potentially unique role of the first corporate investor in each venture.

RESULTS

Table 2 reports descriptive statistics and correlations for the variables (additional descriptive statistics are in the appendix). The average amount raised in a funding round was approximately $4 million, and ventures raised capital in four to five funding rounds on average. A typical funding round had four investors, and in one out of five rounds at least one of the investors was a corporation. Corporations usually co-invested with VC firms (84% of the corporate rounds had both VC and corporate investors), but often did not co-invest with each other (only 25% of the corporate rounds had multiple corporate investors). Overall, the independent variables show considerable variance, and the correlation matrix indicates low correlation among the independent variables. The exception is the correlation between timing defense and firm age variables (r=0.65). Consequently, these variables are entered in the models both separately and simultaneously, but the results are unaffected by this choice.

Our sample distribution is similar to that of previous studies on investor-backed ventures such as that of Gompers and Lerner (2002). For instance, the mix of performance outcomes is comparable to previous studies: 36% of the ventures went public, 31% were acquired, 11% liquidated, and 22% remained private. Fifty-five percent of the ventures had a corporate investor in at least one funding round (only 2% had corporate investors in all rounds). Industry-by-industry distributions are available from the authors.

--- Insert Tables 2-3 about here ---

Table 3 reports the results for the GEE logistic regression analysis predicting the likelihood that a venture enters a corporate investment relationship. Model 1 in table 3 includes the control variables only. We find that longer-tenured ventures (*firm age*), ventures with past corporate relationships (*cumulative corporate investments*) and those started by former corporate employees (*corporate background*) and funded by central VCs (*prominent VC affiliation*) are more likely to enter corporate investment relationships. The results also show that corporate relationships are more likely when VC funding (*availability of venture capital*) is more plentiful in the industry, indicating that corporate and VC

investments are complements rather than substitutes. Ventures in *biotechnology* (Farley and Rouse, 2000) and *electronics* are more likely to form corporate investment relationships than those in the other industry segments that we studied. But, we do not find significant evidence that entrepreneurs in the well-developed entrepreneurial *regions* of Boston and San Francisco are more likely to enter corporate investment relationships than entrepreneurs elsewhere (positive coefficient, not significant at the $p<0.1$ level). In an additional (unreported) regression, we also tested whether the results are sensitive to operationalization of region. Some research suggests that, although Boston and San Francisco share many similarities, they also differ (e.g., Saxenian, 1994). We included separate coefficients for Boston and San Francisco, and (in a different test) for other prolific entrepreneurial regions (i.e., San Diego and Seattle, consistent with our focus on technology ventures), with no significant changes in the original results.

Model 2 introduces the *resource needs* variables: financial and complementary resources. We argued that corporate investment relationships are particularly attractive to entrepreneurs when they have unusually high financial resource needs (H1) and high complementary resource needs (H2). Since the coefficient for financial resource need is positive and significant at the $p<0.01$ level, the results in model 2 and those in the full model 4 support hypothesis 1. Because corporate investors are uniquely positioned to provide large amounts of funding, entrepreneurs are more likely to enter corporate investment relationships in the funding rounds in which their funding needs are high.

In hypothesis 2 we proposed that new firms with higher complementary resource needs are more likely to enter corporate investment relationships. As described earlier, we examined two commonly studied complementary resource needs, manufacturing and marketing. To test the hypothesis, we assessed the coefficients in model 2. The coefficient for manufacturing resource need is positive and significant at the $p<0.05$ level in model 2 and at the $p<0.01$ level in the full model 4, suggesting support for the hypothesis. The coefficient for marketing resource need is not significant in either model.

To further assess the effects of complementary resource needs, we examined alternative measures using alliance intensities compiled from the SDC database as described earlier. Since SDC alliance data are

only available from 1987, we limited this robustness check to a subsample for 1987-2003 (3,086 funding rounds). The influence of manufacturing alliance intensity and the related manufacturing resource need is robust despite the 25-percent reduction in sample size. Manufacturing alliance intensity has a positive and significant ($p<0.01$) effect on the likelihood of forming a corporate investment relationship. Marketing alliance intensity had a negative and significant effect ($p<0.01$). We return to these results in Discussion.

In hypothesis 3 we proposed an ordering (termed "hierarchy") that reflected the preferences of both parties – i.e., complementary resource needs are more influential than financial resource needs in the formation of a corporate investment relationship. To test hypothesis 3, we compare the relative ordering of the three resource needs focusing on the two significant ones, financial and manufacturing resources.[xi] Since the logistic model reports coefficients indicating the effect that a one-unit change in a covariate has on the log odds of relationship formation, the regression coefficients are not directly comparable. In order to compare them, we translated the log-odds into values indicating the probability of relationship formation resulting from a change in the independent variable using a formula suggested by Petersen (1985). The coefficients used to estimate the changes in probabilities are those from model 4, and the probabilities are evaluated at the mean of the dependent variable. In contrast with hypothesis 3, the need for financial resources is a *more* significant predictor of relationship formation than the need for manufacturing resources. A one standard deviation increase in financial resources increases the probability of relationship formation by 10 percent. A one standard deviation change in manufacturing resource needs increases the probability by 4 percent. Finally, we examined the influence of combinations of resource needs by testing interactions between the three resource needs (pairing each with another). No interaction is significant at the $p<0.05$ level, suggesting that resource needs have independent effects. We return to these findings later.

In model 3 in table 3, we introduce the *defense mechanism* variables. We argued that new firms are likely to anticipate that established firms may misappropriate their resources because established firms have strategic interests (particularly related to technology resources including intellectual property). So they rely on defense mechanisms to mitigate this possibility. We examine three defense mechanisms (i.e.,

patents, secrecy and timing) that new firms are likely to use to protect their technology, and so propel them to form relationships. In hypothesis 4a, we proposed that new firms enter relationships when patents are a strong defense mechanism. The coefficient for patent defense is not statistically significant in either model 3 or in the full model 4. Thus, we do *not* find significant evidence that new firms are more likely to enter corporate investment relationships in industries where patents provide an effective shield against appropriation of intellectual property. We expand on this in the Discussion.

In contrast, the positive and statistically significant coefficient ($p<0.05$) for secrecy defense (H4b) in models 3 and 4 indicates that entrepreneurs are more likely to enter corporate investment relationships when trade secrets provide a shield against appropriation of intellectual property by corporate partners. Hypothesis 4b is thus supported.

In hypothesis 5, we predicted that the timing of corporate investment relationships in later funding rounds would protect the new firm's technology resources because entrepreneurs in later rounds are more likely to have embodied the firm's intellectual property, related technologies and knowledge into tangible products, and well-known technical and strategic agendas. To test this hypothesis, we added timing defense to model 3. The positive and significant relationship between timing defense and tie formation in model 3 ($p<0.05$) and in model 4 ($p<0.01$) confirms the hypothesis.

To test hypothesis 6 on the relative influence of defense mechanisms (i.e., termed "hierarchy") given the preferences of both parties, we focused on the two significant ones: secrecy and timing. Similar to our examination of the relative influence of resource needs (H3), we made several comparisons. First, Petersen's (1985) formula confirmed that late timing is a more significant predictor of relationship formation than trade secrecy protection. A one standard deviation increase in timing increased the probability of relationship formation by 4 percent while a one standard deviation increase in secrecy increased the probability by 2 percent. Second, we examined the influence of combinations of defense mechanisms by testing interactions between mechanisms. None is significant at the $p<0.05$ level, indicating that their effects are independent. Thus, hypothesis 6 is supported.

Tables 4 and 5 report the results for the negative binomial and Cox regression analyses for the number of corporate investors and the hazard to first corporate investor, respectively. The negative binomial results in table 4 are similar to the logistic regression results in table 3. Entrepreneurial region also now has consistently positive effects. The Cox results regarding the first corporate investor in table 5 also support our main findings. Together, these analyses provide strong confirmation of the original results.

Table 6 reports the findings for hypothesis 7 where we predicted that new firms are more likely to form a corporate investment relationship when the preferences of the two firms are mutually reinforcing – i.e., when there are mutually desirable resources, then ties are especially likely when there are also mutually desirable defenses. We tested this hypothesis by interacting resource needs with defense mechanisms. We constructed the interactions using the product-term approach (Jaccard, Turrisi, and Wan, 1990), and addressed potential multicollinearity between main effects and interaction terms by centering the variables prior to calculating the interaction, as recommended by Cronbach (1987). Because multicollinearity across interaction terms can be a concern, we tested the interactions in separate models (Gulati and Gargiulo, 1999). We began with the interaction between the resource need (manufacturing) and the defense mechanism (timing) that we hypothesized to be most mutually preferred by both partners. This coefficient (in unreported results) was positive but not significant. But since our empirical results above showed that the most influential resource was financial (not manufacturing) and the most influential defense mechanism was timing (as hypothesized), we conducted an alternative test by interacting financial resource need and timing defense. We report the logistic regression results in table 6 (Cox and negative binomial results have the same pattern, but are not included to save space). Most striking, the positive and statistically significant ($p<0.01$) interaction between financial resource needs and timing defense (model 1) supports the argument that new firms are more likely to form corporate investment relationships when new firms and their corporate partners have preferences for resource needs (i.e., financial) *and* defense mechanisms (i.e., timing) that are acceptable to both partners. To examine the asymmetric prediction (i.e., ties are less likely to form when one party gains (or loses) more than the other), we paired a venture

favorite (i.e., financial resource need) and a corporate repellent (i.e., patent defense). As expected, the interaction between financial resources and patent defense in model 2 had a negative, moderately significant ($p<0.1$) coefficient. These findings support hypothesis 7, showing that new firms are especially likely to form ties when the combination of resource needs and defense mechanisms is mutually acceptable to both firms.

Additional Analyses

We also conducted additional analyses to explore our findings further. First, we examined whether financial resource need and timing defense move in lock step (i.e., larger investment rounds are later). Several tests suggest that this is unlikely. First, the correlation between financial resource need and timing defense variables is *negative* and low (table 2), reducing concerns about relatedness. Second, each variable is a significant predictor of tie formation alone and together, further supporting their distinct effects (Kennedy, 1998: 162). Third, we obtained the variance inflation factors (VIF) for all independent variables in our models (Menard, 2002). All were less than 5.0, the recommended cutoff value (e.g., VIF for financial resource need was 1.09 and timing defense was 2.07), indicating that the variables are unrelated. Finally, we examined our fieldwork. These data suggest much variety in the temporal pattern of financial resource needs. For example, one software firm raised a very large initial round in order to acquire several key technologies, and then subsequent, smaller rounds. A telecom venture raised a large early round in order to fund a very large-scale technical development in high-capacity routers that required contracting with over 100 engineers, then raised a small round, and finished with a moderate round. Still another firm raised smaller rounds early on and then increased their size. Thus consistent with the quantitative evidence, we observed a variety of temporal patterns in round amounts. Overall, we conclude that timing defense and financial resource needs are independent predictors of relationship formation[xii].

Second, we conducted a dyad-level analysis, i.e., which specific pairs of new and established firms choose to partner (e.g., Gulati and Gargiulo, 1999) to gain insight into the *investing firms*, including whether these firms consider these ties as financial transactions rather than strategic relationships as we

have argued. We summarize the dyad results here for a sub-sample for which data were available, and provide methods details and results in the appendix. First and consistent with prior inter-organizational research (c.f., Gulati, 1995b), the dyad analysis showed that pairs of new firms and established firms that had partnered previously were *more* likely to partner, consistent with a strategic relationship. The pairs were also geographically proximate and in related businesses (likely to have complementary resources, H2), and thus had opportunities and motivation for interaction beyond a financial transaction. Third, corporations with high R&D expenditures were more likely to form relationships, suggesting that these ties were a complement to the corporation's own R&D and consistent with many studies emphasizing that corporate investment relationships are primarily strategic (not financial) relationships related to the technology interests of the established firm (e.g., Dushnitsky and Lenox, 2005a,b; Wadwha and Kotha, 2006). Corporations with excess financial resources (free cash flow) were also more likely to form ties (see also Basu et al., 2006), further bolstering H1 regarding their ability to provide large cash infusions. Thus, our dyadic analysis is consistent with corporate investment as a strategic relationship in which established firms are primarily motivated by access to the technology of new firms, and are particularly able to provide the resources needed by new firms (i.e., out-sized financial and complementary resources).

Finally, we ran additional analyses to test the robustness of the results. We ran models without the industry segment controls that were in the original regressions, and models that substituted them for industry-level independent variables (i.e., complementary resources, patents, secrecy). These additional analyses (available from the authors) supported our original results.

--- Insert Tables 4-6 about here ---

DISCUSSION

This study provides important advances for resource dependence theorists studying tie formation and entrepreneurship scholars studying resource mobilization. Regarding the former, resource dependence theorists have focused on the resource needs that push firms to form ties, and so emphasized the cooperative side of ties. But they neglect that firms also anticipate the potential for damaging appropriation

of their resources, and so have left relatively unexplored the competitive side. Regarding the latter, entrepreneurship scholars often portray new firms as weak, passive partners in their ties with established firms, and so have left largely unexamined entrepreneurs as key decision makers (but see Katila and Mang, 2003). In response, we add the potential for resource misappropriation and the new firm lens to the formation of corporate investment relationships in the context of 701 new firms in 5 technology-intensive industries over 25 years.

We contribute to the nascent renaissance of resource dependence theory (c.f., Casciaro and Piskorski, 2005; Gulati and Sytch, 2007). We do so by adding the risk of potentially damaging misappropriation of the firm's own resources to the benefits of gaining resources at the pivotal time of tie formation. Past research emphasizes resource needs at *tie formation* (Gulati, 1995b; Eisenhardt and Schoonhoven, 1996), and defending against misappropriation during *tie execution* (Hamel, 1991; Gulati and Singh, 1998). In contrast, we show that firms simultaneously consider both factors at tie formation. Specifically, we find that new firms form corporate investment relationships when they need resources that established firms uniquely provide, and when they have effective defense mechanisms to protect their own resources, enabling them to maintain their power within the relationship. Conversely, new firms avoid relationships that offer too little resource benefit or entail too much risk.

We also contribute to resource dependence by examining multiple types of partners, with a focus on what we term the *"sharks dilemma"*. We find that firms swim with "sharks" over "safer" partners when they particularly need the unique resources that sharks possess, and can also protect themselves with tailored defense mechanisms.

Unique Defense Mechanisms to Sustain Power

A core insight is the *unique configuration of defense mechanisms* that new firms use to counteract the potential of misappropriation of their resources. In recognizing the competitive side of ties, we find that new firms are more likely to enter corporate investment relationships when they can protect their technology resources through specific defense mechanisms: trade secrets and timing. Trade secrets (an

often overlooked defense mechanism) build a legal barrier around key resources that avoids revealing those resources in a public manner. Timing these relationships in later rounds gives new firms a more defensible set of resources and a more secure strategic agenda. In comparison with the common defense mechanisms of established firms such as equity ownership (Gulati and Singh, 1998) and patenting (Katila and Chen, 2006), secrecy and timing are less expensive to develop and use, and rely on restricting information to protect resources – i.e., they reveal technology resources later and more selectively to desired firms. Also, the traditional approach of dealing with misappropriation post-formation is not a viable option (e.g., enforcement is too costly, cannot break tie until liquidity, and partners do not want board seats). Instead, entrepreneurs uniquely focus on *tie formation*, anticipate misappropriation, and choose partners and timing selectively. As such, timing and secrecy form a unique and more suitable strategy (i.e., tailored to their constraints) for new firms to defend against possible misappropriation of their resources.

In contrast, we unexpectedly find that *patent regime strength* does *not* influence whether new firms form corporate investment relationships. While we anticipated that patenting would be less important than timing and secrecy, we were surprised by its non-significance. In addition to the high expense of patent filing and enforcement, and corporate preferences for ventures with weak patent regimes (Dushnitsky and Lenox, 2005a), our fieldwork suggests a crucial competitive reason: even though patents are legally defensible, their use can reveal information that reduces the element of surprise that is often essential to competitive success, especially for new firms. In contrast, timing and secrecy enable new firms to restrict competitive information to later rounds and to firms of their own choosing. Thus while new firms may use patents as "currency" to buy and sell technology or as competence "signals", they consider less expensive, faster, and information asymmetric mechanisms (i.e., secrecy and timing) in their tie formation choices.

We also offer a distinctly different view of *equity investment*. Research often treats equity investment as a defense mechanism – i.e., governance form that established firms use to control their partners (Pisano, 1990; Gulati and Singh, 1998). By taking an equity position, firms coalign their partners' incentives with their own, and create stronger hierarchical governance. Yet, our findings suggest that this

view misses the crucial point that equity investment is not always a defense mechanism. Rather, corporate investment relationships are exchanges in which established firms give uniquely large financial and operational resources in exchange for access to the new firm's technological resources. So financial resources are an essential feature of the exchange that motivates the tie between new and established firms.

Broadly, our lens on resource misappropriation extends the core logic of resource dependence theory. Resource dependence theorists studying inter-organizational relationships have focused on how firms *reduce* uncertainty by forming ties to gain needed resources from their environments (Scott, 2002). Our contribution is recognizing that these ties also *increase* uncertainty by enhancing the likelihood of unwanted resource appropriation. If successful, these actions alter control of resources, and ultimately lessen partner dependence on the focal firm. Thus, the potential for misappropriation of resources adds a new source of uncertainty for the resource owner, and may diminish power in the future. Since defense mechanisms mitigate this risk, their availability enhances the likelihood of tie formation as young firms anticipate that they can control their resources and so maintain their power in their relationships with corporate partners. There are three key points: 1) Executives anticipate the uncertainty of maintaining dependence and power created by the potential for misappropriation, 2) they form ties when defense mechanisms are available to lower this uncertainty, and 3) defense mechanisms are a focal weapon by which firms sustain their power in relationships. Thus, adding the potential misappropriation of resources and a competitive lens on tie formation are key extensions to the core logic of resource dependence.

Multiple Resources, Bilateral Preferences, and Gaining Power

A closely related core contribution is bringing resources back to the forefront of tie formation. We find that new firms are more likely to form corporate investment relationships when the push for ties is amplified by *multiple resource needs* – i.e., out-sized financial resources and complementary manufacturing resources that established firms uniquely provide. We also observe the key insight of *resource inequality* – i.e., some resources are more crucial for tie formation than others. As expected, we find that manufacturing resources are more significant than marketing resources. By considering the

preferences of both parties, we also offer bilateral insight into why this resource hierarchy emerges. Established firms are likely to prefer manufacturing resources because they offer a better, earlier window into the new firm's technologies. New firms are likely to prefer them because they are often expensive and slow to create, important to operational success, and uniquely available from corporations. In contrast, marketing resources do not have the strategic value that established firms seek because these resources are used downstream from the technical development activity that is usually the primary interest. New firms may also prefer non-equity ties to obtain marketing resources in order to limit ownership dilution and retain flexibility to end the tie if desired.

Unexpectedly, we find that financial resources with their greater fungibility are the most significant resources for tie formation. For new firms, this preference is clear. Financial resources offer very desirable flexibility, and, unlike the use of complementary resources, do not involve sensitive intellectual property. But for the corporation, this preference is not so clear. One reason may be that established firms view corporate investment relationships as financial transactions. But as noted earlier, the many studies of corporate investment relationships (Dushnitsky and Lenox, 2005a,b; Wadwha and Kotha, 2006), our fieldwork and dyadic analysis, the lower valuations accepted by corporate investors (Gompers and Lerner, 2002), and even the widely used term "strategics" for corporate investors suggest that this is not the case. Their motivation is primarily strategic, especially access to new firm technologies. Another reason may be that financial resources give the established firm enough access into the venture's technology resources via arrangements such as observer seats. But a more controversial reason may be that established firms have less power in these ties than expected, making new firm preferences (e.g., for financial resources) more influential. If so, new firms that are highly desirable may actually be the more powerful partner and dominant decision maker in corporate investment relationships. This is a path for future research.

More broadly, our study of multiple resources and partner resource preferences elaborates the core cooperative logic of resource dependence and brings "resources" back to the forefront. Recent research on tie formation, while acknowledging resource interdependence, has focused on social embeddedness (Gulati,

1995b) and on the importance of ties for firm outcomes (Stuart et al., 1999; Baum et al., 2000). In contrast, we showcase resources by highlighting that: 1) resources are multiple and unequal (i.e., fall into hierarchies of importance), and 2) ties are bilateral (i.e., integration of resource and defense preferences is a prerequisite to forming ties). By re-focusing on resources, we develop new testable hypotheses (e.g., hierarchies) within resource dependence theory, and create a realistic view of tie formation as a negotiation in which the outcome depends upon resource needs, defense mechanisms, and partner alternatives.

Toward A Richer View of Entrepreneurs

A key choice of our study is the entrepreneurial lens. While the corporate investment literature invariably takes the corporate side, we take "the flip side." Doing so leads us to question two pieces of conventional wisdom. One is that entrepreneurs are passive, weak partners dominated by powerful established firms. While some firms may be weak, the ones in which established firms are most interested are often not. As described earlier, our fieldwork indicates that new firms are active participants in their own destiny. In our quantitative analysis, we find that the resource preferences of new firms are particularly significant (e.g., their preference for financial resources), even when they may not be the preferences of established firms. Intriguingly, new firms pay particular attention to tie formation, and use distinctive defense mechanisms (not those of established firms) to protect their resources and maintain their power in relationships. Thus, we join the nascent research stream emphasizing the active role of new firms in resource acquisition (Zott and Huy, 2007; Hallen, 2008) and the unique strategies by which they create and sustain power (Graebner and Eisenhardt, 2004; Katila and Shane, 2005; Ozcan and Eisenhardt, 2008).

The other piece of conventional wisdom that we challenge is the rosy view of ties that emphasizes their many benefits, especially for new firms in their ties with established ones. For example, research indicates that new firms accelerate product development, are more innovative, and have more rapid IPOs when they have ties with established firms (Eisenhardt and Schoonhoven, 1996; Stuart et al., 1999; Baum et al., 2000). While these benefits are clearly true, we pose an antipodal view. We note that entrepreneurs pay close attention to tie formation, and avoid ties with too little benefit or too much risk. As an

entrepreneur said to us, "*I just don't think their <corporate partners> interests are with you 100%."*

CONCLUSION

The many studies of inter-organizational relationships mirror their ubiquitous presence and significance for many firms in many industries. Yet, the fundamental tension during tie formation that firms face between the needs for resources of various kinds and concerns about potentially damaging misappropriation of their own resources that makes ties both useful and challenging has been neglected. By exploring this tension in new firms, we hope to help invigorate resource dependence theory and put a bright light on the surprising power of some entrepreneurial firms.

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Table 1. Examples of Sample Ventures and Corporate Investors

Biotech	**Communications**	**Medical**	**Electronics**	**Software**
Ventures				
Genzyme	Ascend Communications	Abaxis	ChipX	Clarify
Gilead	Auspex Communications	Acuson Corporation	Cirrus Logic	Electronic Arts
IDEC Pharmaceuticals	Bridge Communications	Aksys	Cymer	Great Plains Software
Immunex	Cascade Communications	Cephalon	Form Factor	Intuit
Isis Pharmaceuticals	Efficient Networks	Dura Pharmaceuticals	Global Imaging Systems	Object Design
Martex Biosciences	Grand Junction Networks	Endocardial Solutions	Sanmina-SCI Corporation	Rational Software
Matrix Pharmaceuticals	LCI Communications	Hologic	Silicon Wireless	Slate Corporation
Nanogen	Network Equipment Technologies	InSite Vision	Transmeta	Sybase
Tularik	StrataCom	SangStat Medical	Xilinx	Verisign
Corporate Investors				
Abbot Labs	3Com	Abbot Labs	3M	Apple Computer
Baxter	Alltel	American Hospital Supply	AT&T	EMC
Dow Chemical	Ameritech	Baxter	Compaq	Fairchild
Eli Lilly	AT&T	Eli Lilly	General Electric	Hewlett Packard
Hoechst	Cisco	General Electric	General Motors	Hughes Aircraft
Johnson & Johnson	Motorola	Hoffmann-La Roche	HP	IBM
Procter & Gamble	Nokia	Johnson & Johnson	Medtronic	Microsoft
Sandoz	Nortel Networks	Medtronic	Philips	Nortel
Schering-Plough Corp.	Siemens	Raychem	Raytheon	Novell
Smith Kline Beecham	Tellabs	Smith Kline Beecham	Viacom	Xerox

Table 2. Descriptive statistics

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Likelihood of Corporate Venture Investment	.22	.42												
2. Financial Resource Need[1]	6.73	2.86	.18											
3. Manufacturing Resource Need	.62	.47	.01	.06										
4. Marketing Resource Need	.04	.04	.07	.06	.005									
5. Patent Defense	40.4	9.79	.01	-.02	-.02	.15								
6. Secrecy Defense	49.5	5.61	.08	.03	.05	.20	.05							
7. Timing Defense [1]	1.24	.76	.05	-.07	-.03	.01	-.002	.03						
8. Cumulative Corporate Investments	.004	.10	.06	.02	.01	-.003	-.02	.02	.03					
9. Corporate Background	.09	.28	.06	.02	-.06	-.02	-.11	.08	.02	-.01				
10. Prominent VC Affiliation	.30	.46	.05	.15	-.07	-.07	.02	-.03	.07	-.02	-.02			
11. Region	.44	.50	.04	.06	-.10	.11	-.04	.08	.03	-.003	-.03	.17		
12. Firm Age [1]	3.56	1.23	.03	-.03	-.01	-.02	-.01	-.03	.65	.03	-.07	-.02	-.04	
13. Availability of Venture Capital	12.6	40.6	.08	.17	.04	-.02	-.01	-.04	.11	.10	-.03	-.03	.04	.10

[1] logged

Table 3. GEE Logistic Analysis of the Likelihood of Corporate Venture Investment Relationship

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	-2.49 ***	-3.98 ***	-3.56 ***	-4.93 ***
	(0.29)	(0.35)	(0.78)	(0.81)
Cooperation				
Financial Resource Need		0.18 ***		0.18 ***
		(0.02)		(0.02)
Manufacturing Resource Need		0.39 **		0.44 ***
		(0.18)		(0.18)
Marketing Resource Need		-1.16		-0.98
		(1.38)		(1.38)
Competition				
Patent Defense			0.002	-0.002
			(0.01)	(0.01)
Secrecy Defense			0.02 **	0.02 **
			(0.01)	(0.01)
Timing Defense			0.15 **	0.25 ***
			(0.08)	(0.08)
Controls				
Cumulative Corporate Investments	4.61 **	5.39 **	4.68 **	5.56 **
	(2.30)	(2.67)	(2.37)	(2.82)
Corporate Background	0.63 ***	0.63 ***	0.60 ***	0.57 ***
	(0.18)	(0.19)	(0.18)	(0.19)
Prominent VC Affiliation	0.28 ***	0.12	0.27 ***	0.10
	(0.09)	(0.10)	(0.09)	(0.10)
Region	0.09	0.08	0.06	0.05
	(0.12)	(0.12)	(0.12)	(0.12)
Firm Age	0.18 ***	0.18 ***	0.12 **	0.08
	(0.04)	(0.04)	(0.05)	(0.05)
Availability of Venture Capital	0.002 **	0.001	0.003 **	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Biotechnology	0.86 ***	0.81 ***	0.78 ***	0.74 ***
	(0.19)	(0.21)	(0.20)	(0.22)
Communications	-0.30	-1.04 **	-0.24	-1.09 **
	(0.31)	(0.45)	(0.32)	(0.47)
Electronics	0.54 ***	0.55 ***	0.54 ***	0.50 **
	(0.19)	(0.20)	(0.21)	(0.22)
Software	0.08	0.15	0.22	0.29
	(0.20)	(0.20)	(0.21)	(0.22)
Wald Chi square	127.0	218.1	133.9	231.6
P-Value	0.00	0.00	0.00	0.00

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
One-tailed tests for main effects, two-tailed tests for controls. 701 ventures, 4077 funding rounds.
Robust standard errors are in parentheses. All models include unreported temporal effects.

Table 4. GEE Negative Binomial Regression Analysis of the Number of Corporate Investors

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	-2.55 ***	-3.76 ***	-3.25 ***	-4.23 ***
	(0.21)	(0.24)	(0.51)	(0.51)
Cooperation				
Financial Resource Need		0.13 ***		0.13 ***
		(0.01)		(0.01)
Manufacturing Resource Need		0.63 ***		0.65 ***
		(0.07)		(0.07)
Marketing Resource Need		-0.37		-0.36
		(0.78)		(0.77)
Competition				
Patent Defense			0.0001	-0.003
			(0.01)	(0.01)
Secrecy Defense			0.01 **	0.01 **
			(0.01)	(0.01)
Timing Defense			0.07 *	0.17 ***
			(0.05)	(0.05)
Controls				
Cumulative Corporate Investments	0.29	0.62 **	0.28	0.61 **
	(0.27)	(0.26)	(0.27)	(0.25)
Corporate Background	0.42 ***	0.38 ***	0.39 ***	0.26 ***
	(0.09)	(0.09)	(0.09)	(0.10)
Prominent VC Affiliation	0.22 ***	0.12 **	0.21 ***	0.10 *
	(0.06)	(0.06)	(0.06)	(0.06)
Region	0.22 ***	0.16 **	0.23 ***	0.12 *
	(0.06)	(0.07)	(0.06)	(0.07)
Firm Age	0.12 ***	0.12 ***	0.09 ***	0.05
	(0.03)	(0.03)	(0.03)	(0.04)
Availability of Venture Capital	0.002 ***	0.0002	0.002 ***	0.0001
	(0.001)	(0.001)	(0.001)	(0.001)
Biotechnology	0.45 ***	0.32 **	0.39 ***	0.27 *
	(0.13)	(0.14)	(0.14)	(0.14)
Communications	-0.001	-1.03 ***	0.01	-1.10 ***
	(0.21)	(0.26)	(0.22)	(0.27)
Electronics	0.45 ***	0.42 ***	0.41 ***	0.37 ***
	(0.13)	(0.13)	(0.14)	(0.14)
Software	0.12	0.12	0.21	0.20
	(0.14)	(0.14)	(0.15)	(0.15)
Deviance	2657	2492	2654	2478
P-Value	0.00	0.00	0.00	0.00

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

One-tailed tests for main effects, two-tailed tests for controls. 701 ventures, 4077 funding rounds.

Robust standard errors are in parentheses. All models include unreported temporal effects.

Table 5. Cox Regression Analysis of the Hazard of First Corporate Investor

Variable	Model 1	Model 2	Model 3	Model 4
Cooperation				
Financial Resource Need		0.22 ***		0.22 ***
		(0.03)		(0.03)
Manufacturing Resource Need		0.23		0.30 *
		(0.22)		(0.22)
Marketing Resource Need		-0.18		0.12
		(1.50)		(1.48)
Competition				
Patent Defense			-0.01	-0.01
			(0.01)	(0.01)
Secrecy Defense			0.03 **	0.02 **
			(0.01)	(0.01)
Timing Defense			0.42 ***	0.49 ***
			(0.09)	(0.09)
Controls				
Corporate Background	0.79 ***	0.78 ***	0.62 ***	0.60 ***
	(0.18)	(0.18)	(0.18)	(0.18)
Prominent VC Affiliation	0.22 *	0.07	0.17	-0.002
	(0.12)	(0.12)	(0.12)	(0.12)
Region	0.18	0.14	0.10	0.05
	(0.11)	(0.11)	(0.11)	(0.11)
Availability of Venture Capital	0.003	0.001	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Biotechnology	0.73 ***	0.69 ***	0.68 ***	0.60 ***
	(0.18)	(0.21)	(0.19)	(0.22)
Communications	-0.24	-0.73	-0.16	-0.78
	(0.29)	(0.48)	(0.30)	(0.49)
Electronics	0.41 ***	0.34 *	0.37 *	0.28
	(0.18)	(0.19)	(0.20)	(0.20)
Software	-0.09	-0.09	0.12	0.11
	(0.19)	(0.20)	(0.20)	(0.21)
Log Likelihood	-2038.0	-2008.8	-2025.2	-1992.1
P-Value	0.00	0.00	0.00	0.00

*** p < 0.01, ** p < 0.05, * p < 0.10

One-tailed tests for main effects, two-tailed tests for controls. 674 ventures, 357 failures, 2630 rounds.
Standard errors are in parentheses. All models include unreported temporal effects.

Table 6. Interaction Analysis of the Likelihood of Corporate Venture Investment Relationship

Variable	Logistic regression	Model 1	Model 2
Intercept		-2.21 ***	-2.25 ***
		(0.34)	(0.34)
Cooperation			
Financial Resource Need		0.17 ***	0.19 ***
		(0.02)	(0.03)
Manufacturing Resource Need		0.44 **	0.43 **
		(0.22)	(0.22)
Marketing Resource Need		-1.02	-1.06
		(1.48)	(1.46)
Competition			
Patent Defense		-0.003	0.01
		(0.01)	(0.01)
Secrecy Defense		0.02 **	0.02 **
		(0.01)	(0.01)
Timing Defense		0.19 **	0.27 ***
		(0.08)	(0.08)
Cooperation x Competition			
Financial Resource Need x Timing Defense		0.07 ***	
		(0.03)	
Financial Resource Need x Patent Defense			-0.004 *
			(0.003)
Controls			
Cumulative Corporate Investments		5.24 ***	5.56 ***
		-(0.41)	(0.38)
Corporate Background		0.56 ***	0.58 ***
		(0.18)	(0.18)
Prominent VC Affiliation		0.10	0.09
		(0.10)	(0.10)
Region		0.01	0.04
		(0.12)	(0.12)
Firm Age		0.1 *	0.08
		(0.05)	(0.05)
Availability of Venture Capital		0.001	0.10
		(0.001)	(0.10)
Biotechnology		0.68 ***	0.75 ***
		(0.23)	(0.23)
Communications		-1.15 **	-1.11 **
		(0.49)	(0.50)
Electronics		0.47 **	0.51 **
		(0.22)	(0.22)
Software		0.26	0.30
		(0.22)	(0.21)
Wald Chi square		329.2	352.8
P-Value		0	0

*** p < 0.01, ** p < 0.05, * p < 0.10

One-tailed tests for main effects, two-tailed tests for controls.

Robust standard errors are in parentheses. All models include unreported temporal effects.

APPENDIX

Prominent VC affiliation. To construct the measure, we utilize VC centrality rankings based on venture capital syndication networks. Our measure is eigenvector centrality (Bonacich, 1972; Hochberg et al., 2007). Because research has shown that VCs have their most impact on ventures in the early stage (Bygrave and Timmons, 1992), and because we examine technology ventures where early stage investment is particularly crucial (e.g., Sorenson and Stuart, 2001), we explicitly ranked early stage VC firms that invest in research, product development, and initial manufacturing phases (VC firms typically specialize either in early (seed and early stage) or late stage investments). We measured centrality by identifying the ten most central early stage venture capital firms and then coded a dummy variable that equals one when at least one of the ten central firms invests in the new firm's funding round and equals zero otherwise. The results are also robust across various alternative measures of centrality.[xiii] We also tested different groupings of venture capital centrality including the top five, ten, twenty, and thirty firms and found similar results. We also showed the lists to a venture capitalist and to an angel investor (both of whom had extensive venture investment experience) who confirmed the validity of our groupings. We also measured centrality by using continuous rankings for all venture capitalists and obtained similar but slightly weaker results.

Dyad analyses. Dyad-level analyses answer questions about the likelihood that a particular pair of firms (typically labeled firms i and j) forms a relationship. Consistent with prior work that has estimated dyad models (e.g., Gulati and Gargiulo, 1999), we first created venture-by-investor relationship matrices for each funding round in each of the five industries. The cell in each of the matrices takes a value of one if a relationship forms between the two firms in the dyad. Each dyad-round record consists of this dependent variable, along with covariates characterizing the dyad. Since we had no a prior criteria to determine which types of corporations should be included in the risk set of investors in each industry, we decided to include a set that includes all public U.S. corporate investors that invested in a particular industry in our data. Foreign corporate investors (that were included in the firm-level analyses) were excluded due to limited data available on them. In total, we have approximately 150,000 dyad observations in our data. To estimate the dyad models, we used a random effects probit regression (Gulati and Gargiulo, 1999).

Table 1A. Random-effects Probit Analysis of the Likelihood of Investment in a Dyad-round

Variable	
Intercept	-2.75 ***
	(0.18)
Corporate Cash Flow[1]	0.03 ***
	(0.01)
Corporate R&D Expenditure	0.04 **
	(0.02)
Business Relatedness	0.16 ***
	(0.04)
Repeated Tie	2.09 ***
	(0.06)
Geographic Distance[1]	-0.06 ***
	(0.02)
Availability of Venture Capital	0.002
	(0.006)
Prominent VC Affiliation	0.08 *
	(0.04)
Firm Age	-0.02
	(0.02)
Wald Chi square	1188

[1] logged

119,718 dyad round observations. Robust standard errors are in parentheses.
All models include unreported temporal and industry effects.

We included several dyad-level measures. We measured business relatedness by a dummy variable that

takes a value of one if both the venture and the corporation in the dyad operate in the same industry. We measured industry using the primary 2-digit SIC code (Palepu, 1985). We measured repeated tie by a dummy variable that takes a value of one if the young and established firm had partnered previously. As did Sorenson and Stuart (2001), we also measured geographic distance between each venture and each corporate investor in miles (using headquarters location; Kono et al., 1998). Overall, findings in this dyad analysis that only focused on public U.S. corporate investors strongly supported our original findings. Since data that would accurately characterize a relationship between the two partners are often difficult or impossible to get from public sources, the dyad analysis opens up more interesting questions for future work than we can answer here.

Distribution of the sample. In total, our sample ventures operated in 64 different four-digit SIC categories. The biotechnology industry includes biotechnology equipment and research, biosensors, and biotechnology products for humans, animals, and industrial applications (major two-digit SICs 28, 87). The medical industry includes diagnostics, therapeutics, pharmaceuticals, and other medical products and services (38, 80, some 28). The electronics industry includes semiconductors and other electronics such as fiber optics, optoelectronics, laser related devices, power supplies, and instrumentation (35, some 36 and 38). The communications industry includes commercial communications, telephony, wireless, data services, and satellite communications (48, some 35 and 36). The software industry includes software, software tools, and software services (73).

Table 2A. Distribution of the sample.

Characteristics of the sample per industry segment

	Biotech	***Electronics***	***Comm***	***Software***	***Medical***
Status of sample ventures at end of data collection					
Acquired	0.18	0.30	0.44	0.40	0.31
Went public	0.60	0.34	0.11	0.23	0.34
Defunct	0.07	0.15	0.09	0.08	0.11
Characteristics of entire sample (all rounds)					
Average number of rounds	4.41	4.60	3.70	4.89	4.90
Amount invested in round M$	4.76	5.00	7.85	3.06	2.78
Rounds with multiple CVCs	0.04	0.07	0.05	0.03	0.01
Rounds with one CVC	0.22	0.16	0.14	0.14	0.12
Characteristics of corporate rounds					
Amount invested by corporation(s) M$	3.55	2.84	3.62	1.68	2.52
Number of corporate investors in round	1.19	1.50	1.33	1.27	1.12

We also explored our data for industry insights (table 2A). An intriguing comparison is between electronics and communications ventures because our data indicate that both industries have high resource needs, but only moderately defensible technologies. Thus, the tension between cooperation and competition that is core to our study is especially acute in these industries. Yet despite their similarities, electronics ventures (many of whom are semiconductor firms) were more likely and communications ventures less likely to partner. Our field interviews (and descriptive data in table 2a) suggest that one reason is a difference in available partners. That is, electronics ventures form ties with a variety of firms, especially with potential customers (probably because there are electronic components in the products of many different industries) that are less interested in appropriating the technology than competitors would be. In contrast, communications ventures, both in our qualitative and quantitative data, form ties with relatively few, large communications equipment and networking firms such as Lucent, Nokia, and Cisco that compete against each other (probably because communications products are often highly specialized for the communications industry). These partners often have competitive interests in the technology (Gompers and Lerner, 2002 also find that investors in communications ventures are disproportionately competitively related). Thus, communication ventures face a particularly extreme tension (i.e., high resource needs, only moderately defensible technologies, *and* more "shark-like" potential partners). As our

descriptive data (table 2a) indicate, these ventures cope with this extreme tension by raising fewer funding rounds and by being acquired, thereby avoiding "swimming with sharks". Future research could further examine this novel insight for entrepreneurial acquisitions.

Endnotes

[i] Corporate investment relationship is an equity alliance in which the agreement includes an equity purchase of a portion of a private, new (typically less than 7 years old) entrepreneurial venture (termed "new firm") by another company that is typically larger, older, more established, and public (termed "established firm").

[ii] Although not all new firms have this choice, we study firms that do.

[iii] A term sheet is a legal document that lays out an investor's funding terms.

[iv] As part of this study, we conducted interviews with 5 technology entrepreneurs, 3 VCs, 4 corporate venture investors, 2 business unit managers, a lawyer specializing in technology ventures and an angel investor. We read news articles on corporate investments to understand further these relationships. One author co-taught a master's level venture financing course several times with a VC partner.

[v] This is because smaller investments tend to provide larger rates of return (Gompers and Lerner, 2001).

[vi] Appropriation risks are characterized by the degree to which the entrepreneur can protect and exploit the financial benefits of its intellectual property (Levin et al., 1987).

[vii] The timing of investment round tracks the progressive maturation of the venture. Each successive round is tied to a significant development in the venture, such as completion of design, pilot production, first profit, etc., thus demarcating the venture's development stages (Sahlman, 1990).

[viii] Both Venture Economics and VentureOne also cross-check their data (including investment amounts) with entrepreneurs, investors, and public sources (SDC, 2006; VentureOne, 2006).

[ix] Consistent with Lerner (1995) and Kaplan et al. (2002), we examined possible chronological, geographic, and success biases in the two venture financing databases. Consistent with this prior work, we found that Venture Economics was more likely to report earlier and VentureOne later rounds, but did not find other major biases. Specifically, we did not find systematic bias regarding geographical regions: neither Boston nor San Francisco was overrepresented, although Venture Economics was more likely to include fewer Massachusetts and VentureOne more California rounds. We also confirmed Kaplan et al.'s (2002) observation that the databases did not over-sample larger funding rounds or ventures that subsequently go public.

[x] Fixed effects models are not appropriate here for several reasons. First, such models exclude variables that do not vary across rounds within each venture panel, such as the patent defense variable. Second, since our sample includes several ventures for which the dependent variable does not vary over time (either the venture had no corporate investors in any round (45%), or had corporate investors in all rounds (2%)), fixed effects modeling would introduce sample selection bias. Lastly, fixed effects estimation is not recommended for studies with a large number of ventures and relatively short time panels as is the case in our sample (Greene, 2000).

[xi] Since the coefficient for marketing resources was not significant, support for hypothesis 3 is limited to manufacturing types of complementary resources.

[xii] Another possibility suggested by an anonymous reviewer is that new firms do not take corporate investors early on because they might lose financial control of their firms to their corporate investor. This, however, seems unlikely because new firms typically raise only what they need to avoid excess dilution regardless of the investor type involved and established firms often invest at lower valuations than other investors (Gompers and Lerner, 2002).

[xiii] We also verified the temporal stability of centrality by confirming that centrality gave similar results over various sub-periods in the study. We also verified that all central VC firms were investing over the entire study period. All were but one. But since this one has invested since its founding in 1983, it covers most of our study period.