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Who Takes You to the Dance? How Partners' Institutional Logics Influence Innovation in Young Firms

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Abstract

Drawing on institutional theory, we examine how the institutional logics—taken-for granted norms, structures, and practices—of different types of funding partners influence young firms and their search for innovations. We test our hypotheses in a longitudinal study of a complete population of ventures in the minimally invasive surgical device industry in the U.S., supplemented by interviews with industry informants. We find that types of funding partners vary significantly from one another: they all provide resources, but their institutional logics differ. Venture capitalists (VCs) pick young firms with significant patented technologies and help firms launch products, and high-status VCs strengthen both the patenting and product innovations of young firms. Corporate venture capitalists and government agencies also select patent-intensive firms but are less effective than VCs in helping ventures during the relationship because, though these partners often have impressive technical and commercial resources for innovation, their institutional logics constrain how effectively young firms can access their resources. Relative to other types of funding partners, VCs have a closer advisor relationship with the venture; greater power, influence, and access to resources; better-paced and more-motivating milestones; and better understanding of the commercialization process. Our results extend the institutional logics literature to interorganizational relationships and suggest that the choice among types of funding partners may have unanticipated effects on firms' innovation beyond the financial resources gained through the relationship.

Keywords: new firms, innovation, institutional logics, funding partners, venture capital, medical device industry, entrepreneurship, venture funding

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Innovation is at the heart of the performance of many new technology-based firms. The ability to create technical breakthroughs and turn them into commercial products is central to their survival and success. New firms usually need external resources to create and accelerate innovation, so they often form relationships with investors to gain resources. Research and the popular press frequently focus on venture capitalists (VCs) in this role (Gulati and Higgins, 2003; Pahnke et al., 2015). But new firms, particularly technology-focused ones, often have choices among types of funding partners, including the government and corporate venture capitalists (CVCs), and the sheer volume of money invested in new firms by non-VC organizations is significant. CVC investment represented almost a third of all U.S. venture capital funding—about a billion dollars—in the first quarter of 2014 (CB Insight, 2014). These different types of investors all typically offer useful technical and commercial resources to new firms, but investor types are not homogeneous, and differences between different types of partners might affect ventures' innovation. Institutional theory sheds light on why.

Although much institutional theory research focuses on established firms, a stream of institutional work on new firms has emerged, centered on the effects of institutions on young firms' choices. It looks at how institutions influence how new firms get started (Hiatt, Sine, and Tolbert, 2009; Sine and Lee, 2009) and are organized (Burton and Beckman, 2007; Powell and Sandholtz, 2012). Some recent work at the nexus of institutions and new firms also delves more deeply into the process of how institutions influence young firms and points to institutional logic—taken-for-granted understandings of what is meaningful and appropriate in a setting—as a link between organizations and their actions (Glynn and Lounsbury, 2005; Thornton, Ocasio, and Lounsbury, 2012).

Institutional logics encompass a coherent set of assumptions and values about what is perceived as meaningful (i.e., rational and necessary) and appropriate for an organization to do. Institutional logics are deeply embedded in organizational members' cognition and preferences, and they influence how members of organizations interpret and act in their relationships with others. The configuration of attributes within an institutional logic, which characterizes a particular class or type of organizations and their actions, can offer a more accurate and complete understanding of firms' actions than simpler explanations like resources and incentives alone or constructs that focus only on individual organizations (e.g., an organization's logic, culture, or capabilities). Despite the prior insights of the institutional logics perspective, several open questions relevant for new firms remain. While some empirical work describes how changes in institutional logics in academic book publishing (Thornton, 2004), retailing (Eisenhardt, 1988), and banking (Marquis and Lounsbury, 2007) alter the actions of organizations, including their compensation policies and executive succession, much of this literature focuses on larger societal logics (e.g., market or growth logic) rather than the specific logics represented by institutional actors that interact with young firms. But different types of partners may bring distinct institutional logics to bear in their interactions with young firms, leading to differences in young firms' actions in response. Types of partners differ in their values and expectations about the appropriate processes for running a new firm and may in turn influence the advice provided to, choices made by, and performance of young firms.

Building on the existing work on institutions and young firms, our purpose is to examine how ties to different types of funding partners influence the technical and commercial innovations of young firms. We define funding ties as the formal relationships of young firms to organizations that provide non-debt financing, and we focus on three types of partners—VCs, CVCs, and government agencies—that commonly finance young U.S. firms. A key advantage of this focus is that it enables us to explore the implications for innovation of three distinct institutional logics that are anchored in the ideal institutional types of professions, corporations, and the state, respectively. As a partner's institutional logic is likely to be especially influential for the outcomes of the lower-power actor (Pfeffer and Salancik, 1978), such as a new firm in a funding relationship, this is an ideal setting in which to explore the influence of institutional logics on partners. We test our hypotheses using the complete population of 198 minimally invasive surgical (MIS) device ventures in the U.S. over a 22-year period and supplement these data with extensive fieldwork, including interviews with more than 40 industry informants.

INSTITUTIONAL LOGICS AND YOUNG FIRMS' INNOVATION

Institutional theory emphasizes how the actions of organizations and individuals within them are shaped by what is perceived as proper, rational, and necessary (Tolbert, David, and Sine, 2011). Although much institutional theory research centers on how norms and shared expectations influence the actions of established firms, a stream of institutional work has started to look at new firms. This work delves into the process of how institutions influence young firms and points to institutional logics as a link between organizations and their actions (Marquis and Lounsbury, 2007; Thornton, Ocasio, and Lounsbury, 2012). Research indicates that institutional logics underpin the aims and values of an organization and influence how the organization operates internally and interacts externally (Marquis and Lounsbury, 2007; Thornton and Ocasio, 2008). As taken-for-granted assumptions and practices, institutional logics are deeply embedded in organizational members' cognition and preference about what is appropriate and meaningful, and they influence how members of organizations ''perceive, pay attention to, evaluate, and respond to environmental stimuli'' (Almandoz, 2014: 443). Institutional logics are therefore the lens through which organizational members view reality.

Institutional logics become manifest in a configuration of attributes that fit together, and these coherent sets of attributes render logics apparent (Glynn, 2000). Thornton, Ocasio, and Lounsbury's (2012) research on institutional logics suggests that organizations develop a basis of norms—underlying rules about membership, authority, and legitimacy. Organizations also develop a basis of strategy—how the organization's members view their identity and strengths (Ocasio, 1997; Glynn, 2008)—and a basis of attention—assumptions that members make about how to succeed and which issues require attention. These attributes of institutional logics link assumptions and values with actions.[1]

[1] We draw from Thornton, Ocasio, and Lounsbury (2012) and personal communication with the authors to create the categorization of basic elements of institutional logics appropriate for our setting.

Empirical work has also started to examine institutions, their institutional logics, and young firms. One strand addresses institutions and the founding of new firms. A significant finding is that founding rates of new firms are higher when there is greater normative acceptance of new enterprises (Sine and Lee, 2009). Almandoz (2014) further focused on bank founders as carriers of logics and found that their prior embeddedness in a particular logic imprints them, influences the decisions they make, and affects their entrepreneurial success. For example, a background in finance influenced the cognitive structures of founders such that they emphasized financial considerations and gave less weight to community ones. Thus the institutional environment, whether intentionally or not, often shapes how new firms come into being.

A second research strand looks at existing institutions as key templates for new firms' organization and strategy. Benner and Ranganathan (2013) showed that firms in the process of entering a new technical field were perceived as having better chances to succeed if their prior institutional logic and form were more similar to those of the new field. Other research has also pointed to a link between logics and resistance to adopting templates foreign to a logic's core assumptions (Battilana and Dorado, 2010). The core idea is that institutionalized design blueprints—even when offering uncertain survival advantage—often shape the organizational form that a venture takes or is expected to take.

Despite its insights, this literature emphasizes broad field-level logics and leaves open the issue of whether young firms' actions can also be traced to the institutional logics of their partners. Vasudeva, Zaheer, and Hernandez (2012) offered some evidence from established firms suggesting that they can. They found that a partner's institutional origins in a particular country can affect the focal established firm's ability to combine resources with that partner. Given the effects on established firms, it is likely that the embedded attributes of institutional logics would give rise to differences in the norms, strategies, and attention that collectively affect how funding partners act in relationships and thus have a particularly strong influence on their new-firm partners.

Venture Capital and Professional Logic

Venture capitalists are professionals in private equity firms that specialize in financing young firms with high growth potential. They select these ventures on behalf of institutional investors and try to guide entrepreneurs to exits with positive returns (Hellmann and Puri, 2000). Given these aims, VCs have incentives to encourage technical and commercial innovation to achieve novel products, and they and their contacts often have substantial commercial and technical resources.

VCs' basis of norms. The basis of norms for VCs—membership criteria, legitimacy, and authority structure—is likely to influence ventures' innovation. The craft of a VC is embodied in individuals rather than in organizational hierarchies and procedures. Venture capitalists often have similar educational experience (i.e., an undergraduate technical degree with an MBA or Ph.D. from an elite school) and managerial experience (i.e., at least five years in executive positions). While they typically have connections to technologists, venture capitalists themselves are usually not highly technical and may follow technology fads (Guler, 2007; Sorenson and Stuart, 2008). Many people we interviewed for this study who struggled to develop technology looked to their VC investors for guidance but were often frustrated by how little useful advice they received. A startup engineer described how he approached a VC ''with an optimal [technical] solution,'' but ''they didn't recognize it.'' Another interviewee added, ''Explaining the day to day [priorities] for design and development—they don't want to hear it, and they are not going to understand it if you tell them.'' The educational and managerial backgrounds of VC professionals make them more valuable for commercial and less valuable for technical innovation.

VCs' legitimacy is derived from a successful track record of investments, reinforced by awards such as *Top Investor* (The Midas List), as well as from the perceived exclusivity of the profession (Hallen and Pahnke, 2015). Despite their exclusivity, venture capitalists are more accurately quasi-professionals because they, like book editors, lack any formal certification into the profession (Thornton, 2004). Rather, the VC profession is learned through socialization such as by apprenticeship and step-by-step promotion to partner. Building external networks, venture-management expertise, and often industry expertise is a key part of this socialization. Altogether, the sources of VCs' legitimacy favor the development of commercial but not necessarily technical innovation in young firms.

Institutionalized authority structures are also likely to influence ventures' innovation. VC firms are traditionally organized as partnerships. Venture capitalists are typically top decision makers at the partner level and have significant autonomy over their investments. As our interviewees noted, because VC partners value direct contact and emphasize ''call anytime'' relationships, entrepreneurs get to receive advice and ''deal with the decision-maker right off the bat,'' which can directly boost innovation. Another practice rooted in history is that VC partners take board seats and ratify key decisions such as ventures' major resource commitments (Hallen, Katila, and Rosenberger, 2014) even when they are not majority shareholders. Given their disproportionate authority and what some interviewees describe as an ''autocratic style,'' venture capitalists thus have substantial opportunities to influence major decisions such as technical and product development. But the logic can also backfire if venture capitalists influence technology decisions beyond their immediate expertise. As an engineer told us,

> I was the creative engineer that was going to help adapt the base technology idea to the new, crazy opportunity that they [VCs and the board] saw. . . . It felt like they thought they had a vision but in reality they switched—every other month. At the time, as an engineer, I thought it was pretty cool. I didn't have to publish anything, or do any of the dirty work . . . we were always filling in sexy new things. . . . I got to do things that got everybody excited. And I never had to do the real work. In this sense it was almost to a negative that they [VCs] were involved.

Traced back to their professional norms, venture capitalists' behaviors are likely to be more helpful for commercial and less helpful for technical innovation.

VCs' basis of strategy. The basis of strategy—how VCs perceive their identity and strengths—is also likely to influence ventures' innovation. Given their professionalism, venture capitalists view themselves as skilled business advisors, able to translate technical insights into successful products. Consistent with this identity, venture capitalists do the heavy lifting: team building, developing strategy, active board participation, and even interim management (Hallen, Katila, and Rosenberger, 2014). Because commercial and venture expertise so heavily underlies their professional identity, venture capitalists prefer to solve product problems, not technology problems. One venture capitalist explained, ''The CEO emailed me last night with a very specific product question. I emailed back saying that I do not know how to answer that question for you. But if I were you, I would ask myself the following five [high-level, product market] questions and then I listed the questions.'' When asked whether he thought this approach was effective, the venture capitalist said it was and told us that the founder ''emails back immediately and says, wow, I did not even think [to ask] three of those.''

Reflecting their professional identity, venture capitalists often take pride in advising. Rather than simply selecting high-quality ventures and then leaving them alone, venture capitalists perceive themselves as making a difference in the success of young firms, particularly related to management and understanding markets. In fact, many venture capitalists see themselves as co-creators of new enterprises that ''make a difference'' (Graebner and Eisenhardt, 2004). Venture capitalist professionals normally oversee only 6 to 12 firms at a time and prefer to invest in firms within driving distance (Gompers and Lerner, 2004), which enables them to have the frequent face-to-face interactions with entrepreneurs that are typical of the close client relationships of other professionals such as lawyers, doctors, and accountants. Illustrating this close relationship, one venture capitalist described how he pushed for a pivot in a firm's product strategy that ''prevented them from getting into a wrong path.'' Because their identities are tied to being professional business advisors, venture capitalists are especially helpful for commercial innovation.

Venture capitalists also typically use their business expertise as the basis for advocating for formal processes such as product development and other management systems (Hochberg, Ljungvist, and Lu, 2007). As Sine and David (2010) noted, many of these practices, including their content, timing, and organization, are taken for granted by VC professionals: perception about the appropriate thing to do is deeply embedded. One common institutionalized VC practice is to replace a founder–CEO with a professional manager after several stages of product development. This professionalization of management is believed to speed up development of the venture, as founders (especially technical ones) may not feel comfortable with sales and marketing or understand their optimal customer and would ''sell to anybody who would pay the least bit of attention to them'' (Wasserman and Flynn, 2007: 4). Although perhaps not intentionally, the formalization of management processes is likely to help the young firm structure product development, target the right customers, and thus further commercial innovation. The discipline from the venture capitalists' professional logic is well aligned with the structure shown to aid product development (Brown and Eisenhardt, 1997; Katila and Ahuja, 2002), although it may be misaligned with technical innovation as it constrains the free-form process underlying successful creative work (Katila and Chen, 2008).

Venture capitalists also view their networks of professional contacts as a key strength. For example, a venture capitalist described how entrepreneurs used his network for advice about customers: ''The [firm] knows they can call us about almost anything. And if I don't know it, I can say 'Go call so and so and tell them that you're working with me.''' An entrepreneur illustrated this point in terms of hires: ''When a CEO needs a VP of R&D or a VP of regulatory quality assurance, they can go to the VC [to get] a list of people that they worked with in the past who are really good and that they recommend. So that's a very practical kind of thing, which is done much more by the VCs than the other investors.'' Venture capitalists' assistance in connecting entrepreneurs to advice and hiring networks adds to the formalization of the venture, which, in turn, particularly helps commercial innovation.

VCs' basis of attention. The basis of VC attention—assumptions about how to succeed and so where to focus—is also likely to influence ventures' innovation. According to ingrained routines in venture capital, venture capitalists manage the relationship through attention to helping ventures achieve milestones that relate to progress toward timely liquidation of the VC fund. A serial entrepreneur told us, ''VCs, their number one concern [is] 'how much money do you want from me and how do I get my money back.''' An institutionalized practice calls for VCs' funds to be liquidated at the end of a fixed, ten-year term with VCs often raising successor funds by the midpoint of the existing fund's term (Gilson, 2003). This pressure to perform in a rhythmic and timely manner is an impetus for milestones such as product progress tied to the young firm's readiness for an exit event. All venture capitalists we interviewed had adopted routine, time-paced practices to hit this schedule. One explained, ''We have a strategy [event] off-site once a year, a 3–4 day event. We ask the entrepreneur to prepare material [about the product portfolio], we bring outside consultants for them to think about product development, we also talk about other questions that are more operationally oriented.'' Another venture capitalist asked her firms to ''present at regular intervals—redo their pitch to avoid only seeing a company when they raise money.'' For entrepreneurs, regular milestones create discipline in product development, such as when ''prior to a board meeting, there's this big push to get stuff done'' (Feld and Ramsinghani, 2014: 124). The goal setting and rhythm that VCs require are well aligned with practices that enhance commercial innovation (Brown and Eisenhardt, 1997; Katila and Chen, 2008). But though time-paced deadlines and milestones are useful for commercial development, many entrepreneurs see them as unduly constraining for more-technical work. One entrepreneur said, ''Sometimes it takes poking around for a few years and learning about the clinical space and trying to understand where the tools you made are most useful. When you've got 50 million bucks of VC funding hanging over you and you've got 3 million dollars a month going out the door, you can't really do that.'' Another offered that VC ties are ''not about exploration.'' Because the time frames required for technical innovation are often longer and the discovery process more open-ended (Davis and Eisenhardt, 2011), time-pacing by VCs may not enhance or may even damage technical innovation.

Finally, VCs attend to the institutionalized milestones of staged financing (Hallen and Eisenhardt, 2012). A venture capitalist described the process to us this way: ''You invest to get to a prototype. . . . And then, you raise the next round, and it's to take the prototype to a commercializable device.'' Staged financing pushes ventures to complete milestones that relate to commercial innovation like a prototype (Series A), product and customer proof points (Series B), and market launch (Series C) as a way to manage (Dorf and Byers, 2005). Though beneficial for commercial innovation, the time horizon for staged financing is often too short for significant technical innovation. Thus attending to well-known milestones and time-paced discipline helps ventures progress on commercial innovation but less on technical innovation.

Although venture capitalists have incentives to encourage technical and commercial innovation as their compensation is tied to their ventures' success and they and their contacts have significant commercial and technical resources, their professional institutional logic—business craft as a valued skill, substantial power and authority, deep personal engagement with entrepreneurs, business advisor identity, attention to financial and managerial discipline, and taken-for-granted milestones for ventures—particularly favors commercial innovation. Holding other factors constant, we propose:

Hypothesis 1a (H1a): New firms with more funding relationships with venture capitalists will achieve less technical innovation than new firms without them.

Hypothesis 1b (H1b): New firms with more funding relationships with venture capitalists will achieve more commercial innovation than new firms without them.

Corporate Venture Capital and Corporate Logic

Corporate venture capital units are the new-firm-investing arms of corporations. CVCs seek strategic advantages for their parent corporations through investing in new firms that provide a window on novel technologies, products, and potential acquisitions (Katila, Rosenberger, and Eisenhardt, 2008). To a lesser extent, CVCs also seek superior financial returns for the corporation (Hallen, Katila, and Rosenberger, 2014). Given these aims, CVCs have incentives to encourage their venture partners to achieve innovation, and corporations often have substantial financial, technical, and commercial resources to assist ventures in doing so (Winston-Smith, 2009; Park and Steensma, 2012). But despite aligned incentives and significant relevant resources, the institutional logic of corporations makes the innovation outcomes of their venture partners somewhat problematic to achieve.

CVCs' basis of norms. The basis of norms for CVCs—membership criteria, authority structure, and legitimacy—is likely to influence the innovation of young firms. CVC units are typically composed of 3 to 30 corporate employees, often reporting to the chief technology officer. CVC executives frequently have experience within the corporation, such as in business-unit roles (Siegel, Siegel, and MacMillan, 1988), and may have technical expertise. They typically are knowledgeable about the corporation's resources, such as R&D, sales channels, and manufacturing facilities (Dushnitsky and Lenox, 2006). A corporate venture capitalist we spoke with said, ''I took the job because I believed that startups needed help navigating the corporate organization.'' But because CVC executives are embedded within a corporate hierarchy and must coordinate with corporate and business units to access resources for ventures, they have limited authority, which may diminish their usefulness for ventures.

As entrepreneurs are usually attracted to particular corporations, not individual CVC executives, a CVC's legitimacy generally stems from the prestige and success of the corporation. An entrepreneur said this about a CVC partner: ''Amazing company . . . their distribution element—fantastic. Their reps: Honest, intelligent, everywhere.'' A CVC executive added, ''We can bring a lot of market validation to an early stage company in terms of 'yes, we've checked this out' . . . we know the technology is real and that isn't necessarily what traditional venture capital firms [can] do.'' But though it is usually easy to access resources in a VC tie through the focal venture capitalist, it is challenging with CVCs. Corporations with CVC units are often very large. They typically use an M-form or even a matrix with many dispersed units that have their own aims (Chandler, 1962; Galunic and Eisenhardt, 2001), such that internal cooperation can be difficult (Martin and Eisenhardt, 2010). Corporate logic further guides who has authority to make decisions (Thornton and Ocasio, 1999), and though these authority structures are taken for granted inside the organization, they are often confusing to outsiders. As one entrepreneur said, ''Who is the decision maker? Is it any one person or is it somebody you may not talk to early in the game?'' An implication of corporate institutional logic is that processes for gaining resources are complex. One entrepreneur described how this complexity delayed his progress: ''Slow as molasses: resources need to get approved, technical decisions involve modifications in contracts . . . they can't get anything done. And their hierarchy—it's just a pain.'' And while corporations have excellent technical resources, many interviewees were puzzled by the difficulty of accessing them. One founder said, ''[Corporate engineers], all they want to do is get into fights about [technology], because they feel threatened, what they have done isn't good enough, kind of thing.'' Commercial development can be a source of similar friction with CVCs, as another founder described: ''What surprised me the most is that the business units weren't involved in market development or helping [us] understand the market—because that's what I would hope to get from a strategic [CVC] partner. They know the customers much better than we do.'' Helpful resources exist within corporations, but dispersed authority, complex and slow organizational processes, and internal conflicts within their institutional logic complicate ventures' access to these resources.

CVCs' basis of strategy. The basis of strategy—how CVCs perceive their identity and strengths—is also likely to influence ventures' innovation. As carriers of corporate logic, CVC executives typically see themselves as scouts for new technologies, products, and potential acquisitions and brokers between business units and ventures (Wadhwa and Kotha, 2006; Hallen, Katila, and Rosenberger, 2014). A strength is their knowledge of the corporation—what is going on, who is doing it, and where the corporation is going—and matching that knowledge with investments in ventures. Yet CVCs may not broker effectively because influence, power, and action traditionally lie within business units in big corporations, and serendipity can become important. A founder explained, ''One of the VPs was walking down and stopped the low level business development guys [I was hanging out with them trying to once again move the deal] and said 'Hey, what's going on with [that deal]? I thought we did that deal?' Of course the deal wasn't made and he was like 'Oh, I guess we better do that deal.' And a month later, the deal was done.'' Thus CVCs may not be sufficiently central in an often-complex internal corporate communication network to have sufficient ability or awareness to put all the pieces together.

To attract ventures, CVCs often maintain distance, as suggested by the ''sharks dilemma,'' to avoid scaring off entrepreneurs with threats of corporate dominance (Katila, Rosenberger, and Eisenhardt, 2008; Diestre and Rajagopalan, 2012; Hallen, Katila, and Rosenberger, 2014). CVC executives often go to great lengths to convince entrepreneurs that the venture will be at arm's length or, as one CVC executive said, ''not in the pocket of the corporation.'' This distance may enable tie formation, but it makes it more difficult for entrepreneurs and CVC executives to identify which corporate resources might actually help the new firms. Unlike venture capitalists, CVC executives often do not take seats on the venture's board (Maula, Autio, and Murray, 2005). As a CVC executive noted, ''None of us would lead a deal . . . and few of us would go onto the board.'' But this practice further diminishes influence on and understanding of technical and product strategies—key topics at venture board meetings (Garg and Eisenhardt, 2015). These attributes of the corporate institutional logic impede communication and cooperation such that ventures are less able to access corporate resources, and CVCs are less able to understand which corporate resources and ties will be most valuable to a new firm. Traced back to their strategy within the corporate logic, CVCs may not be effective in enhancing the technical and commercial innovation of their venture partners.

CVCs' basis of attention. The basis of attention for CVCs—assumptions about how to succeed and so where to focus—can also influence ventures' innovation. CVC executives perceive success as tied to making venture investments that pay off strategically and perhaps financially for the corporation. ''The way [big corporations] renew, you buy technology and drop it into this huge distribution team and then you battle over market share,'' described an industry informant. So unlike venture capitalists, CVC executives are less likely to pay attention to helping ventures grow. Consistent with this view, a founder told us, ''They were definitely looking into what we were doing but they were pretty much hands-off in terms of their development and strategy . . . there wasn't really anyone pushing for the fundamental business side of things.'' A major focus is to ensure that ventures' innovations fit with the products of the corporation. As an entrepreneur told us, ''The strategics are trying to build a portfolio, they're trying to build their business. They want to have a product that supports their brand.'' But these integration efforts may take entrepreneurs away from realizing their own product visions. Further, the corporate strategy may change such that the venture is no longer in the ''sweet spot'' of the corporation and may lead CVCs to ignore such a venture.

Another key assumption that guides CVCs' perception of where to focus is the time horizon. Unlike the rapid, time-paced liquidation of VC funds, CVCs market themselves as ''patient capital.'' So although CVCs provide staged financing like VCs, their focus and related time horizon are tied to their corporation's long-term, strategic needs. In contrast with venture capitalists, whose professional logic directs attention to disciplined processes and milestones, the corporate logic puts less attention on the formalization of startup activities that is linked to high-performing commercial innovation.

Overall, corporate venture capitalists have incentives to encourage the technical and commercial innovation of ventures, and corporations typically have significant resources that are useful for ventures' innovation. But their corporate institutional logic—dispersed authority, complex and slow decision making, internally conflicting goals, focus on corporate strategic aims, and long time horizon—is unlikely to enhance ventures' innovation. As corporate venture capitalists often maintain distance from ventures, such as by not taking board seats, they are also often far from influencing ventures' decision making, especially as compared with venture capitalists. Holding other factors constant, we propose:

Hypothesis 2a (H2a): New firms with more funding relationships with corporate venture capitalists will achieve less technical innovation than firms without them.

Hypothesis 2b (H2b): New firms with more funding relationships with corporate venture capitalists will achieve less commercial innovation than firms without them.

Government Agencies and State Logic

Government agencies as funding partners are public-sector bureaucracies with one or more mandates on behalf of citizens. The primary government agency for funding medical device firms is the National Institutes of Health (NIH). The NIH is organized around application areas and diseases and has funded many medical breakthroughs. A key aim of the NIH is to improve public health. In its venture funding the NIH seeks technical innovations that advance science and commercial innovations that turn technical innovations into useful products. Thus NIH officials have an incentive to encourage their grantees to pursue both technical and commercial innovations, and the NIH itself has immense technical resources and commercial understanding (e.g., FDA approval process) to help them do so (Toole, 2012). Yet the NIH's institutional logic may make only technical innovation most likely.

Government agencies' basis of norms. The basis of norms at the NIH—its membership criteria, authority structures, and legitimacy—is likely to influence ventures' innovation. The focal person is the program officer, who is often a Ph.D. scientist with an academic background. Unlike their venture capitalist and corporate venture capitalist counterparts, scientific credentials are critical for program officers, and other experiences are desirable but not typical. A program officer assembles review panels composed of non-governmental scientific experts. Together, this panel and the program officer have the authority to designate which ventures will receive funding. Consistent with a state logic, program officials rely on well-documented procedures to ensure fairness, transparency, and diverse access to funds in selecting firms and to ensure appropriate expenditures by funded firms. Several interviewees (both with NIH funding and without) praised its academic peer-review process and merit-based evaluation by scientists as a ''stamp of legitimacy'' for the young firm. In contrast to the perception of VCs as faddish (Sorenson and Stuart, 2008), the legitimacy of the NIH as a high-status funding source stems from the prestige of NIH science, the selectivity of its funding, and its careful merit-based analysis of grant applications (Wessner, 2008). Although the focus on scientific credibility is potentially useful for technical innovation, entrepreneurs reported that the grant process slowed commercial innovation because ''aims that were put on paper 9 months ago may not be relevant anymore.'' One elaborated on this misfit:

> We put in a very clinically based [proposal]. You look at the review committee and there's not a single clinician on there. So if I tell [reviewers] what I do to develop products, it doesn't sound like the kind of things they do in their labs. For example, milestones and the projects are not quite the same. You have to frame things in a way that looks a little more basic science for them to wrap their heads around and get excited about what we're doing. And then morph that into what we're used to doing which is product development and hopefully have enough flexibility and have the funds ready to do what we need to do.

At the NIH, a deeply embedded norm is scientific evaluation that drives legitimacy. Thorough peer review of proposals is the ''gold standard,'' and because the reviewers are ''the experts,'' ''there is no need to question their decision.'' But given time lags, this norm is often misaligned with fast-moving commercial development. The two-tier authority structure is also a potential hindrance. Because entrepreneurs cannot talk to the reviewers directly, the program officers become the focal point of contact. The overall effect is that the institutionalized process of evaluating applicants chiefly on scientific merit, though perhaps beneficial for technical innovation, may hinder commercial innovation.

Government agencies' basis of strategy. The basis of strategy—how NIH officials perceive their identity and strengths—is also likely to influence ventures' innovation. Program officers see themselves, as one of them described to us, as facilitators of ''interactions at the scientific level'' and have technical expertise that can be helpful to ventures' innovation. Program officers we interviewed offered examples of how they mentored grantees based on their expertise, typically by spotting a discrepancy in the firm's application. For example, a program officer described a venture that he ultimately funded: ''Something was off in the original proposal. I sat down with the company on multiple phone conversations and thoroughly went through this with them.'' Unlike venture capitalists, program officers regard themselves as technical experts who actively mentor applicants on how to spin their business ideas into science-focused grant applications that will be favorably reviewed.

Program officers also regard themselves as stewards of public funds. Thus they attempt to fund geographically diverse ventures in the districts of congressional members. This helps to ensure that grantees reflect the entire country, but it also makes the hands-on, active engagement like that of venture capitalists infeasible. Thus while this practice makes sense from a state logic, it distances program officers from their ventures and makes guidance difficult. As stewards of public funds, program officers also emphasize egalitarian access to resources once ventures are funded. This pursuit of equality leads to cookie-cutter activities like one-size-fits-all conferences in which entrepreneurs learn in lock-step about topics like FDA approval. But if entrepreneurs want tailored access to the NIH's resources that might fast-track their innovations, they have no clear path through the NIH.

Government agencies' basis of attention. The basis of attention for program officers—assumptions about how to succeed and so where to focus—are likely to influence ventures' innovation as well. NIH officials, including program officers, typically believe that successful innovation requires scientific autonomy. In contrast to venture capitalists who often have weekly face-to-face meetings with entrepreneurs, NIH officials broadly share the belief that intense monitoring of new firms is unnecessary and even counterproductive. Such oversight is likely to impede creative science and is fundamentally misaligned with the logic of the NIH. As a program administrator described it, ''We are spending billions of dollars on projects—what are they producing? They produce knowledge. We fund inquiry. Following up after funding would question and undermine the whole system.'' Success is seen as stemming from encouraging outstanding applicants with promising projects to apply and be accepted for funding. In fact, the NIH encourages long-term funding to allow investigators to ''concentrate on their research for 3 to 4 years unimpeded'' (Wyngaarden, 1987: 871). This approach is consistent with the belief that autonomy and freedom fuel scientific discovery but is misaligned with high-performing commercial innovation that benefits from ongoing joint problem-solving efforts, advice, and monitoring (Marion, Dunlap, and Friar, 2012). Our interviewees also indicated that government oversight was inconsistent with growing ventures and was ''incredibly passive'' and ''likely to disappear with months on end without any response.'' The central point is that emphasis on scientific autonomy may aid technical innovation but may limit commercial innovation.

NIH program officers also focus on selection. They actively attend to attracting many and diverse grant applications to ensure a wide applicant pool, mentoring them to write successful proposals, and assembling review panels that ensure open, merit-based selection (Wessner, 2008). An interviewee described a multistate bus tour through underrepresented states to promote awareness of government funding. Thus program officers focus attention on the selection of excellent entrepreneurs and projects, and they give less time after funding to monitoring. This practice fits the NIH's belief that autonomy is central to scientific discovery.

Program officers also pay attention to what they see as the public good. Rather than providing benefits to corporate shareholders or VC investors, their emphasis is on scientific advances that may significantly improve public health. Consistent with this view, NIH funding supports projects rather than the entire enterprise. In fact, many young firms are funded by the NIH more than once for separate projects. Though the project model is well suited to support technical innovation, it is less useful for commercial innovation (Azoulay, Graff Zivin, and Manso, 2011). A medical device entrepreneur told us, ''The downside in my mind is that with NIH grants—they're very specific about what you can do. . . . You can't do marketing work with it.'' Consistent with its focus on the public good, the NIH (like most government agencies) also does not take equity positions in new firms. Though such nondilutive funding can be attractive to entrepreneurs, it also creates a distant and less-influential relationship with the new firm as compared with a venture capitalist who usually has a board seat and a close relationship. Nonetheless, distance fits with the NIH's belief in autonomy for carefully selected grantees.

Table 1. Institutional Logics of Venture Capitalists, Corporate Venture Capitalists, and Government Agencies

Attributes	Venture Capitalists Professional logic	Corporate Venture Capitalists Corporate logic	Government Agencies State logic
Basis of norms			
Membership criteria	Educational credentials Managerial experience	Executive experience, usually within the corporation	Scientific credentials
Legitimacy	Prestige of successful investment track record	Prestige of corporation driven by commercial and technical success	Prestige of government science Selectivity of funding
Authority structure	Partnership with simple hierarchy Partners with high decision-making authority	Complex hierarchy of business units and corporate office Dispersed authority with slow decision making and internal conflict	Panel of scientific experts led by program officer with high decision-making authority
Basis of strategy			
Identity	Highly involved professional business advisor to entrepreneur-clients Co-creator of difference-making ventures	Corporate scout for technologies and products Broker between ventures and corporation	Mentor for the application process Steward of public funds
Strengths	Ability to formalize processes Network of professional contacts	Knowledge of the corporation Knowledge of the industry	Careful merit-based, scientific evaluation Technical and commercial (e.g., clinical trials) resources of the agency
Basis of attention			
Assumptions: how to succeed	Close personal relationships with clients	Portfolio of high-quality strategic investments for the corporation To a lesser degree, financial returns	Scientific autonomy for high-quality entrepreneurs
Assumptions: where to focus	Routinized and rhythmic timetables for venture progress Milestones of staged financing	Distant time horizon of patient capital Fit of investments with corporate strategy	Selection of high-quality entrepreneurs Selection of projects to promote public good

The NIH and its program officers have incentives to encourage both technical and commercial innovation because the success of the NIH depends on cutting-edge technologies embodied in commercial innovations that enhance public health. The NIH also has substantial scientific and commercial resources (e.g., related to FDA approval) that are useful for ventures' innovation. Yet the state institutional logic of the NIH—emphasis on science, egalitarian access, application but not relationship mentoring, physical distance to grantees, and no-equity funding— may particularly favor creative tasks associated with technical innovation. Holding everything else constant, we propose:

Hypothesis 3a (H3a): New firms with more funding relationships with government agencies will achieve more technical innovation than firms without them.

Hypothesis 3b (H3b): New firms with more funding relationships with government agencies will achieve less commercial innovation than firms without them.

As we proposed above, each of the three common funding partners for new firms—venture capitalists, corporate venture capitalists, and government agencies—is highly selective, has commercial, financial, and technical resources, and has incentives to encourage technical and commercial innovation. Yet each also has a distinct institutional logic anchored in the ideal logics of a profession, a corporation, and the state, respectively. Table 1 summarizes the different attributes of VCs, CVCs, and government agencies, like the NIH. A focus on the professionalism of the craft and the client relationship is prevalent in venture capital, a focus on corporate performance and hierarchy is characteristic of corporate venture capital, and a focus on fairness and common good permeates government agencies. As we have hypothesized, these factors are likely to influence the choices their young-firm partners make that drive their innovation in the minimally invasive surgical device industry.

METHODS

We analyzed the relationship between funding partners and ventures' innovation over a 22-year period from 1986 to 2007. Our sample is the population of U.S. medical device firms that were founded to develop products for minimally invasive surgery (MIS). We chose the MIS device sector because it has many new firms, multiple types of investors (Rapoport, 1990a, 1990b; Kruger, 2005), and particularly reliable measures of technical and commercial innovation. We also chose MIS devices because the government's role as a gatekeeper in commercialization (i.e., mandatory FDA approval) enabled us to limit funding partners' potential influence on commercial innovation through avenues outside the focal relationship. The ability to rule out such potential influences (e.g., network connections and the influence of reputation suggested by Stuart, Hoang, and Hybels, 1999) made it easier to separate selection and treatment in our setting. We also chose the sector because MIS devices are significant for health care—they reduce patients' trauma and healing time by the use of tiny incisions. We began the sample in 1986, the year in which the first minimally invasive surgical procedure was performed in the U.S. (Mack, 2001), and ended with the firms founded in 2003 but continued data collection through 2007 or until the firm declared bankruptcy, was acquired, or went public. A strength of our study is its use of a complete population of new firms since the inception of the industry sector.

Because the MIS device sector is not clearly defined by standard industrial classifications, we triangulated data from several sources to develop a comprehensive and accurate database. Our first source was survey data from a medical device industry intelligence firm, Windhover Information. This provided a list of all firms with financial transactions in the sector, such as financing, alliances, joint ventures, IPOs, bankruptcies, and acquisitions. Second, we integrated these data with membership lists and conference proceedings from relevant trade organizations, such as the American College of Surgeons, International Society for Minimally Invasive Cardiac Surgery, and Medical Device Manufacturers Association, in order to include new firms without financial transactions. Third, we used the National Institutes of Health's Medical Subject Heading (MESH) classification to identify keywords related to MIS devices based on their usage in medical publications, and then we searched Lexis Nexis and Google to identify firms that use any of these keywords in their business or product descriptions. This enabled us to capture new firms that lack financial transactions and membership in professional societies.

By combining these databases that rely on complementary sources, we compiled a list of 639 MIS device firms. Firms that did not meet sample criteria were excluded. We dropped 192 firms because they did not develop MIS devices but rather were solely manufacturing or distribution firms, another 73 firms because they were outside the U.S., and firms that were subsidiaries of larger companies or were public. As a last step, we consulted two industry specialists who verified the accuracy of our final list of 198 firms.

Our primary data sources for funding partners were four fundraising databases. For VC and CVC funding relationships, we used VentureSource and VentureXpert. These databases rely on distinct yet complementary data sources. Entrepreneurs provide the VentureSource data, investors are the source of the VentureXpert data, and both databases cross-check their data with archival sources. Further, the databases are complementary because they emphasize different funding stages. VentureSource has particularly accurate data on early rounds, whereas VentureXpert's strength is later funding rounds. We built on methodology employed by other researchers to combine the databases (Lerner, 1995; Kaplan, Sensoy, and Strömberg, 2002; Katila, Rosenberger, and Eisenhardt, 2008). When there were missing data or discrepancies between the two databases, we turned to archival sources, including Lexis Nexis, to obtain data and resolve differences. For NIH's research and Small Business Innovation Research (SBIR) funding relationships, we used the federal government's FedSpending and the SBIR program databases, respectively. The data are compiled from the Federal Procurement Data System, the Federal Assistance Award Data System, and the Small Business Administration records and provide an accurate and comprehensive list of grants awarded by government agencies.

We also collected data on technical innovations from the Delphion Patent Database and U.S. Patent and Trademark Office, and on commercial innovations from the Food and Drug Administration's 510(k) and premarket approval (PMA) databases that track medical device applications. We supplemented these data with information from other sources, e.g., The Corporate Technology Directory, ABI/Inform Global, The Leadership Library, Who Owns Whom North America, and One Source North America Business database. The result was a unique database on 198 MIS device ventures over 22 years.

We supplemented the primary archival data with interviews. We interviewed over 40 industry informants, including entrepreneurs, venture capitalists, corporate venture capitalists, government administrators and review panel members, device engineers, surgeons, FDA regulators, and industry experts. We interviewed founders and employees in early-stage and late-stage startups, some successful and others not. We triangulated these interviews by talking to funding partners representing all three logics. The interviews lasted between 20 and 75 minutes and occurred between February 2007 and June 2014. We used two interview protocols, one for entrepreneurs and one for funding partners. These protocols included chronological questions about how and why funding ties formed (or not); how technology and products were included in investment talks; how, when, and what type of guidance was given and requested; how communication and monitoring were done; how and what resources were mobilized through funding partners; and how partners and funding targets differed. This fieldwork sharpened our theoretical arguments, strengthened our understanding of causal mechanisms, and helped us interpret results. We also drew on case studies of the financing of several MIS device ventures (Rapoport, 1990a, 1990b).

Measures

Innovation. We examined two innovation outcomes. We measured *technical innovation* using patented technologies (patents) and *commercial innovation* using product approvals (products) by each firm yearly. Patents are an appropriate measure of technical innovation because they are an especially strong defense against misappropriation of intellectual property in the medical device industry (Cohen, Nelson, and Walsh, 2000) and, according to our interviewees, are a major intermediate step in the creation of a new MIS device. Product approvals are an appropriate measure of commercial innovation because FDA approval to market a device demonstrates feasibility, effectiveness, and innovativeness of the product, and medical devices cannot be sold in the U.S. without this approval. A new product introduction typically closely follows FDA approval.

We collected annual data on patents that each firm had applied for (and later received) and on product approvals for each firm. There are two types of FDA device approvals: 510(k) and PMA. The type of approval depends on the novelty and the potential safety risks of the device. Devices that are substantively similar to previously approved ones qualify for a 510(k) approval. Radically novel devices require a PMA approval, but they are relatively rare in the MIS device sector (about 2 percent of product approvals). We combined the two types of approvals and also ran the results with 510(k) approvals only, with consistent results. In all, the sample firms received 2,647 patents and 931 FDA approvals during the study period.

Funding partners. We operationalized three independent variables to measure funding relationships. We measured the new firm's *venture capital funding relationship* with a binary variable set to one if the new firm received a venture capital investment in a year and zero otherwise. Prominent VCs may be particularly likely to influence innovation because they may have better connections and more powerful influence, so we also assessed in a sensitivity analysis how a relationship with a high-status VC may influence innovation differently. We used the VC's eigenvector centrality in venture capital syndication networks to assess its prominence (Bonacich, 1987) and measured *high-status VC partner* with a binary variable set to one when at least one of the top 30 most high-status VCs invested in the new firm's funding round and zero otherwise.

We measured the new firm's *corporate venture capital funding relationship* with a binary variable set to one if the new firm received a corporate venture capital investment in a year and zero otherwise. We coded investment partners as corporate if they provided equity (not loans or public offerings) and were non-financial firms. In a sensitivity analysis, we also assessed whether a *related CVC partner* affected innovation differently, expecting that related partners' competitive interests might make them particularly passive. CVCs were coded as related if they operated in the same two-digit industry as the venture (Palepu, 1985) and zero otherwise.

We measured the new firm's *government funding relationship* with a binary variable set to one if the new firm received federal funds from the National Institutes of Health (NIH) in a year and zero otherwise. We included both NIH's research and SBIR grants that the focal firm received, and we analyzed their aggregate and separate effects.

Finally, we created two related yearly measures for the independent variables above: *number of funding relationships* with a partner and *total amount of funding received* from the partner.

Controls. Because the availability of financial resources may influence a young firm's innovation (Cohen, 1995), we controlled for *funding amount* by the total inflation-adjusted investment by all funding partners in each firm annually. This variable was measured in millions of U.S. dollars and logged to mitigate skew.

We controlled for the new firm's *geographic location* in an innovation-rich region because local infrastructural and cultural differences may influence a young firm's innovation performance. Because our data indicate that innovation hubs in MIS devices include the traditional entrepreneurially dense regions of San Francisco and Boston as well as the Minneapolis (Minnesota) and Orange County (California) regions, we included these four region controls. We measured location by an unreported binary variable coded as one if the new firm was headquartered in one of the metropolitan area zip codes associated with one of the four hubs and zero otherwise. In alternate tests, we included metropolitan statistical area (MSA) fixed effects (a dummy variable that equals one if the young firm is located in a particular MSA and zero otherwise) to capture differences in local resource availability (Samila and Sorenson, 2010), and our results held.

Because longer-tenured firms can have more experience in innovating, we controlled for *firm age* in years between the year the new firm began operations and the current year. We also collected *firm size* data, measured by number of employees yearly, but these data were available for a subset of 30 firms only. Because firm age and size are highly correlated, we used firm age as the control. In the equations that predict product approvals, we also included the new firm's *patents* as a control. We obtained the data on control variables from ZoomInfo, VentureXpert, VentureSource, The Corporate Technology Directory, and Lexis Nexis. We also cross-checked with each firm's current and archived websites (archive.org) when available.

We controlled for the *founding team*, expecting that a venture with accomplished founders would be more likely to innovate because founders' particular backgrounds (M.D., Ph.D.) could help types of innovation, and more-experienced teams in general may have learned to innovate more predictably (Beckman, Burton, and O'Reilly, 2007). More details of the founding team measures and mechanisms are provided in the Online Appendix (http://asq.sagepub.com/supplemental).

Finally, we included controls for *temporal effects* that might contribute to innovation outcomes, such as macroeconomic conditions, beyond our other controls. We operationalized these effects by unreported yearly dummy variables for 1986–2007. Because the sample size is reduced, we used a continuous year measure in our difference-in-differences models. We also considered *temporal factors common to each match.* Like Short and Toffel (2010), we included dummy variables indicating each year before, during, and after the match year to capture any changes in resource availability, such as government administration shifts, and our original results held.

Statistical Methods

Because we focused on the effects of treatment (funding tie), a statistical challenge was to show that differences in innovation can be attributed to the treatment and not to other factors such as selection to a particular treatment. Types of funding partners may affect new firms' innovation because they (1) pick innovative new firms more effectively (*selection*), (2) better help new firms be innovative during the relationship (*treatment*), or (3) both.[2]

Difference-in-differences. We accounted for selection bias by using several approaches. The primary method was difference-in-differences analysis (Abadie, 2005; Smith and Todd, 2005; Short and Toffel, 2010). This method yields separate estimates for selection and treatment effects, allows us to compare the effects of treatments over time across the matched treated and (counterfactual) comparison firms, and is robust when two firms are not a perfect match in initial performance but their performance trends are parallel. The first step is to identify a treatment, a group that received that treatment, and a control group (comparison) that did not. The second step is to calculate the differences in outcomes before and after the treatment for both groups. The third step is to calculate the difference in these two numbers, i.e., difference-in-differences across these two groups (Bertrand, Duflo, and Mullainathan, 2004). To test whether a treatment changed the performance trajectory of a firm, we estimated:

$$y_{it} = \beta_0 + \beta_1 treat_i + \beta_2 after_{t-1} + \beta_3 treat_i * after_{t-1} + controls_{it-1} + \varepsilon_{it-1}$$

where y_{it} is the firm i's performance in year t, $treat_i$ equals one if new firm i formed a focal type of funding relationship and zero if it did not, and $after_{t-1}$ equals one if the current year is after the treated firm received funding and zero for the years before it. For the analysis, we identified a control group that would have been eligible for the same type of funding but did not form the tie. The goal was to find matching firms that were as close as possible to treated firms so that they could be used to estimate the counterfactual, i.e., a firm that received funding should not differ from its paired firm that did not receive funding, in ways that are relevant for the outcome.

To build our matched sample, and following Shadish, Cook, and Campbell (2002), we first theorized about how our ventures were selected to a treatment

[2] In a randomized experiment—the ideal approach to evaluate treatment effects—randomization takes care of many threats to causal inference. Because each firm is randomly assigned to a treatment or control group, the two groups look alike on average, and selection bias is eliminated. But randomization was unavailable to us, so we used a quasi-experimental design that facilitated causal inference by focusing on a population of firms over time and by attempting to make the treatment and comparison groups comparable by matching and including a rich control set.

(funding tie) and then used the constructed criteria to form matched pairs of firms that were comparable, except for the tie. As our focus was innovation, those firm characteristics that could drive a difference also in innovation performance were relevant. We conducted interviews with funding partners and entrepreneurs about partner selection. We asked funding partners about their selection criteria for investing in new firms, rejected firms, and firms that rejected their offers. We asked entrepreneurs about their funding partners, investors that rejected them, and investors whom they rejected. These interviews revealed that prospective partners are strategic in their tie formation. Also, contrary to popular wisdom, VCs are not the investors of choice for all entrepreneurs. Some entrepreneurs either did not pursue or turned down VC investment, usually to retain more control. Most important, interviewees converged on a few key criteria for determining whether funding relationships form. As a result, we matched firms on geographical location, founding year, and patenting as the interviews suggested, and in sensitivity analyses we added matching also on the quality of the founding team and technology. Details of matching are provided in the Online Appendix. Altogether, we created matched pairs of firms that have ties with VCs (36 pairs, 432 firm-years), CVCs (66 pairs, 792 firm-years), and the NIH (17 pairs, 204 firm-year observations).

Firm fixed effects. While difference-in-differences analysis pays attention to selection bias, like all methods, it is not perfect. Increasingly accurate matching comes with a price: firms that do not have a match in the data are dropped, and so the findings may not generalize to a larger population. To account for these issues, we used a second statistical approach, full-population firm fixed effects analysis using the xtnbreg command in STATA (Hausman, Hall, and Griliches, 1984; Benner and Tushman, 2002), as an alternative to matching (Imai and Kim, 2011). We also used random effects and the generalized estimating equations (GEE) regression method, which accounts for auto-correlation that may arise because each firm is measured repeatedly across multiple years (Liang, Zeger, and Qaqish, 1986). Our findings were highly consistent. As has become common in venture funding studies (Li and Prabhala, 2007), we report difference-in-differences as our main analysis.

In all models, the data consist of a panel of observations on firm-years. To further facilitate causal inference, we lagged independent and control variables by one year. Because our dependent variable is counts of innovation, we used negative binomial regression (Poisson regression findings are consistent).

RESULTS

Table 2 reports descriptive statistics and correlations. New firms typically received a patent each year and an approval for a new device every other year. While many firms formed a tie with a VC (73 percent), a CVC (36 percent), or the NIH (12 percent), a significant number (23 percent) never received funding from any of these sources. The independent variables show considerable variance, and the correlation matrix indicates low correlations among them. The exception is the correlation between VC partner and the amount of funding received. Consequently, we entered these variables both separately and simultaneously, but the results were unaffected by the choice. We also obtained the

Table 2. Descriptive Statistics and Correlations*

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Patents	1.23	3.07															
2. Products	.48	1.28	.25														
3. VC partner	2.06	4.56	.13	.10													
4. CVC partner	.14	.54	.04	.05	.50												
5. Government partner	.05	.31	.01	.06	.06	.02											
6. High-status VC partner	.11	.31	.20	.09	.13	.02	.04										
7. Firm age	6.93	4.57	–.05	.05	.00	.04	–.01	–.12									
8. Funding amount (logged)	.38	6.24	.13	.07	.67	.34	.19	.15	–.04								
9. Founding team size	1.23	.50	.02	–.04	–.05	–.04	–.01	.00	–.06	–.05							
10. Entrepreneurial experience	1.48	3.78	–.05	–.07	.00	.02	–.02	–.01	.00	.01	.11						
11. Work experience	2.52	3.50	.04	–.03	.03	.03	–.03	.04	–.05	.00	–.02	.11					
12. Managerial experience	2.31	3.60	.07	.00	.01	.02	–.01	.03	–.02	–.02	.00	.09	.88				
13. Academic experience	.17	.38	.05	.10	–.03	–.06	.15	–.04	–.02	.04	.11	.16	.09	.12			
14. MD founder	.25	.43	.15	–.04	.04	.00	.02	.14	–.10	.09	.23	.09	.08	.14	.33		
15. PhD founder	.27	.45	.02	.15	–.02	–.04	.21	–.11	.03	.03	–.07	.04	–.21	–.17	.22	.06	
16. MBA founder	.10	.30	.06	–.02	.00	.04	–.05	.02	–.04	–.01	.05	–.01	.08	.14	–.12	–.01	–.17

* N = 1,299 firm-years.

variance inflation factors (VIFs) for all independent variables (Menard, 2001), and these were less than 5.0, the recommended cut-off value, indicating that the variables are unrelated.

Table 3 presents the difference-in-differences analysis for the effects of VC funding partners on the innovation of new firms. Models 1 and 3 include the control variables only. Consistent with the rest of our analyses, we find that new firms receive more patents (technical innovation) when they have more funding (funding amount) and more product approvals (commercial innovation) when they have more patents (technical innovation) and are older (age). Models 2 and 4 introduce VC partner effects on patent and product approvals, respectively. We argued that new firms with funding partners steeped in the professional logic of VCs were likely to achieve less technical innovation (H1a) and more commercial innovation (H1b) than firms without these relationships. To test the hypotheses, we assessed the coefficient for the interaction term between VC partner and after-investment variables in models 2 and 4, respectively. This coefficient is positive but not significant in model 2, and positive and significant in model 4. The results thus show that ties with VCs have no significant effect on technical innovation (H1a) but help yield significant commercial innovation during the relationship (H1b). Further, the positive and significant coefficient for VC partner in model 2 and the lack of significance for the same coefficient in model 4 show that VCs select new firms with strong

Table 3. GEE Negative Binomial Difference-in-differences Analysis for VC vs. Non-VC Funded Firms*

	Patents		Products	
Variable	Model 1	Model 2	Model 3	Model 4
Intercept	58.29•••	43.01••	83.21•••	74.22•••
	(14.73)	(14.98)	(20.03)	(20.29)
VC partner		0.21••		0.01
		(0.09)		(0.13)
After treatment		–0.88••		–2.55••
		(0.33)		(1.03)
VC partner × After treatment		0.18		2.38••
		(0.35)		(1.04)
CVC partner	0.00	–0.03	0.11	0.09
	(0.06)	(0.06)	(0.07)	(0.07)
Government partner	0.58•••	0.66•••	0.07	0.14
	(0.16)	(0.17)	(0.23)	(0.23)
Patents			0.08•••	0.08•••
			(0.01)	(0.01)
Firm age	0.01	0.00	0.05•••	0.05•••
	(0.01)	(0.01)	(0.01)	(0.01)
Funding amount (logged)	0.04•••	0.04•••	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Wald chi-square	151.30	190.40	150.14	149.96

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 432 firm-years.

(prospects for) technical innovation but lack the ability to select firms that have superior commercial innovation. The results confirm the importance of separating the selection and treatment effects in evaluating the influence of partners on new firms.

Table 4 examines CVC funding partners. We argued that new firms with partners steeped in the corporate logic are less likely to achieve both technical and commercial innovation (H2a and H2b). The coefficient for the interaction term between CVC partner and after-investment variables is not significant in either model, but the coefficient for CVC partner in model 2 is positive and significant. In a sensitivity test that further refined our matching (detailed below), the coefficient for the interaction term on patenting becomes negative and significant, suggesting support for H2a. The results show that CVCs select new firms with strong technical innovation (patents) but that these ties may have a weak negative (or no) influence on the technical innovations and no influence on the commercial innovations of ventures.

Table 5 examines government (NIH) funding partners. To test H3a and H3b, that new firms with funding ties steeped in the state logic are more likely to achieve technical innovation and less likely to achieve commercial innovation, we assessed the coefficient for the interaction term between NIH partner and after-investment variables. Unexpectedly, the coefficient is negative and significant in model 2 and positive but not significant in model 4, failing to support the hypotheses. The results show that the NIH chooses to form ties with new firms with more technical innovation (patents) but that its ties unexpectedly

Table 4. GEE Negative Binomial Difference-in-differences Analysis for CVC vs. Non-CVC Funded Firms*

Variable	Patents: Model 1	Patents: Model 2	Products: Model 3	Products: Model 4
Intercept	17.41	–9.07	94.55•••	76.88••
	(13.69)	(19.68)	(17.73)	(24.15)
CVC partner		0.83•••		–0.12
		(0.11)		(0.13)
After treatment		0.24•		–0.05
		(0.13)		(0.15)
CVC partner × After treatment		–0.19		0.11
		(0.16)		(0.19)
VC partner	0.78•••	0.67•••	0.28•	0.14
	(0.12)	(0.14)	(0.16)	(0.19)
Government partner	1.26•••	0.42••	0.20	0.36
	(0.17)	(0.21)	(0.23)	(0.25)
Patents			0.08•••	0.14•••
			(0.01)	(0.01)
Firm age	–0.01	–0.02••	0.05•••	0.07•••
	(0.01)	(0.01)	(0.01)	(0.01)
Funding amount (logged)	0.01	0.02•	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Wald chi-square	386.41	478.06	186.00	218.03

• $p < .10$; •• $p < .05$; ••• $p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 792 firm-years.

Table 5. GEE Negative Binomial Difference-in-differences Analysis for NIH vs. Non-NIH Funded Firms*

Variable	Patents: Model 1	Patents: Model 2	Products: Model 3	Products: Model 4
Intercept	13.83	–27.82	96.18•••	251.20•••
	(13.60)	(37.31)	(17.74)	(47.46)
Government partner		1.68•••		0.14
		(0.23)		(0.34)
After treatment		0.52••		1.07•••
		(0.26)		(0.31)
Government partner × After treatment		–1.02•••		0.02
		(0.28)		(0.36)
VC partner	0.45•••	–0.71••	0.21	–0.33
	(0.12)	(0.22)	(0.16)	(0.28)
CVC partner	0.11	0.50••	0.22	1.28•••
	(0.11)	(0.23)	(0.15)	(0.28)
Patents			0.08•••	0.03••
			(0.01)	(0.02)
Firm age	–0.01	0.03••	0.05•••	0.08•••
	(0.01)	(0.02)	(0.01)	(0.02)
Funding amount (logged)	0.03•••	0.05••	0.01	–0.02
	(0.01)	(0.02)	(0.01)	(0.02)
Wald chi-square	329.07	145.08	184.28	117.49

• $p < .10$; •• $p < .05$; ••• $p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 204 firm-years.

yield a lower likelihood of technical innovation and have no effect on commercial innovation.

We also confirmed all findings with an alternative specification of hypothesized variables—i.e., total yearly funding received from each partner type, rather than a binary or count variable. As described in more detail below, we also confirmed the results for our hypotheses by redefining matches, increasing the richness of the control set, and adding firm fixed effects.

Sensitivity analyses. To examine the robustness of our difference-in-differences analysis, first we used alternative matches to deal with potential remaining differences between the treatment and control groups. Our original matches were based on geographical location, founding year, and patenting, but our interviews suggested two added selection criteria: *founding team* and *technology quality*. Despite the reduction in sample sizes when these two criteria were added (see the Online Appendix), our original findings were confirmed. In addition, CVC funding ties now has a statistically significant negative effect on venture patenting, as expected in H2a. Second, we added variables to control for any remaining differences, including whether a young firm was funded by a *prominent VC* and the *availability of resources* for the MIS sector from each type of funding partner in a particular year, with consistent results. Finally, because alternative matches and controls do not capture unobservable characteristics that may be relevant, we examined *firm fixed effects* in the difference-in-differences analyses. Given the many variables, it is unsurprising that some equations did not converge, but the main result patterns were consistently supported. Our main findings are robust to several added controls, matching criteria, and models with alternative specifications.

We confirmed these results with alternative statistical analyses that use the entire population, not just matched firms. First, we ran fixed effects, random effects, and GEE regressions in the full population. This enables a more complete analysis of the counterfactual (non-treated) firms and inclusion of comprehensive control variables, including founding team characteristics and year dummies. These analyses yield results that strongly parallel our original findings, as shown in tables 6 and 7. Second, we explicitly attempted to model the selection process (rather than ''controlled out'' selection to resemble randomization) using a two-stage instrumental variables approach (Wallsten, 2000; Li and Prabhala, 2007). Although the lack of strong instruments was limiting, these tests support our main findings. Third, we verified that the matched samples were representative of the full population by using t-tests on key observable variables (results available from the authors). We then examined potential scope conditions for the institutional logics' influence.

Scope conditions: Funding partners. We explored the heterogeneity of funding partners within each type. To probe H1, we analyzed whether ties with high-status VC firms differed from ties with low-status ones. In table 8, we observe that ties with high-status VCs positively and significantly influence both technical and commercial innovation during the relationship.

Table 6. Negative Binomial Analysis of Patents with Founding Team Data*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	72.83•••	70.51•••	74.70•••	72.65•••	71.67•••	–84.43••	–121.68
	(17.75)	(17.76)	(17.75)	(17.75)	(17.76)	(28.05)	(419.61)
Number of VC partners		0.03••			0.02••	0.02••	0.02•
		(0.01)			(0.01)	(0.01)	(0.01)
Number of CVC partners			0.12••		0.06	–0.06	–0.07
			(0.06)		(0.07)	(0.08)	(0.08)
Number of government partners				–0.17	–0.15	–0.18	–0.23•
				(0.13)	(0.13)	(0.13)	(0.13)
Number of high-status VC partners	0.95•••	0.92•••	0.96•••	0.95•••	0.93•••	0.74•••	0.64•••
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.12)	(0.13)
Firm age	0.01	0.01	0.01	0.01	0.01	–0.04••	–0.06•••
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Funding amount (logged)	0.05•••	0.03•••	0.04•••	0.05•••	0.03•••	0.02••	0.02••
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Founding team size	–0.10	–0.08	–0.10	–0.10	–0.08	–1.51••	–7.69
	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)	(0.68)	(627.56)
Founding team size squared	0.01	0.01	0.01	0.01	0.01	0.39••	2.47
	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)	(0.18)	(209.19)
Entrepreneurial experience	–0.06•••	–0.06•••	–0.06•••	–0.06•••	–0.06•••	–0.01	–0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)
Managerial experience	0.01	0.01	0.01	0.01	0.01	–0.04••	–0.05••
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Academic position	0.05	0.09	0.06	0.07	0.10	0.57••	0.90••
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.25)	(0.32)
MD	0.59•••	0.58•••	0.58•••	0.58•••	0.57•••	0.53••	0.41
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.20)	(0.25)
PhD	0.42•••	0.41•••	0.42•••	0.44•••	0.43•••	0.36•	0.48•
	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.21)	(0.28)
MBA	0.58•••	0.57•••	0.58•••	0.58•••	0.57•••	0.00	0.08
	(0.12)	(0.13)	(0.13)	(0.12)	(0.13)	(0.27)	(0.36)
Wald chi-square	349.76	354.71	353.35	349.27	355.09	124.31	107.35

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.

* Models 1–5 GEE, model 6 random effects, and model 7 fixed effects regression results. Standard errors are in parentheses. All models include unreported year and geography effects. N = 1,299 firm-years.

To probe H2, we analyzed whether ties with related CVC firms differed from ties with unrelated ones. In table 9, we find that ties with related CVCs decrease the technical innovation of the new firm relative to unrelated CVCs.

To further understand H3 and the unexpected negative influence of ties with the NIH on the technical innovation of ventures, we analyzed whether ties with NIH-SBIR differ from those with NIH-research. The results in table 10 indicate no significant differences between the two groups. We return to these results in the Discussion.

Scope conditions: Industry life cycle. We also compared the influence of the logics over the life cycle of the MIS sector to gain insight into whether the influence of a particular logic depends on the environment. As institutions may have stronger, more-consistent effects during stable periods (Barley and

Table 7. Negative Binomial Analysis of Products with Founding Team Data*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	7.78	9.13	8.8	7.8	9.24	–115.78••	2.59
	(24.99)	(24.94)	(24.97)	(24.99)	(24.95)	(36.22)	(19.95)
Number of VC partners		0.03••			0.03••	0.04••	0.02••
		(0.01)			(0.01)	(0.01)	(0.01)
Number of CVC partners			0.08		0.003	0.09	0.03
			(0.08)		(0.09)	(0.10)	(0.06)
Number of government partners				0.01	0.02	–0.07	–0.02
				(0.14)	(0.14)	(0.14)	(0.10)
Number of high-status VC partners	0.73•••	0.70•••	0.73•••	0.73•••	0.70•••	0.39••	0.75•••
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.17)	(0.11)
Patents	0.10•••	0.10•••	0.10•••	0.10•••	0.10•••	0.02•	0.08•••
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm age	0.02	0.02	0.02	0.02	0.02	–0.01	0.02••
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Funding amount (logged)	0.02••	0.002	0.01•	0.02••	0.001	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Founding team size	3.17••	3.11••	3.18••	3.17••	3.11••	1.17	2.25••
	(1.37)	(1.37)	(1.37)	(1.37)	(1.37)	(1.04)	(1.02)
Founding team size squared	–0.99••	–0.97••	–0.99••	–0.99••	–0.97••	–0.35	–0.70••
	(0.44)	(0.44)	(0.44)	(0.44)	(0.44)	(0.27)	(0.32)
Entrepreneurial experience	–0.13•••	–0.13•••	–0.13•••	–0.13•••	–0.13•••	–0.06	–0.12•••
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Managerial experience	0.03••	0.03•	0.03••	0.03**	0.03•	0.02	0.02•
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
Academic position	0.60•••	0.65•••	0.61•••	0.60•••	0.64•••	0.39	0.69•••
	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)	(0.33)	(0.11)
MD	–0.48•••	–0.47••	–0.48•••	–0.48•••	–0.47••	–0.20	–0.62•••
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.30)	(0.12)
PhD	0.55•••	0.54•••	0.55•••	0.55•••	0.54•••	0.24	0.59•••
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.31)	(0.10)
MBA	0.01	0.02	0.01	0.01	0.02	–0.75••	–0.12
	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.38)	(0.16)
Wald chi-square	197.18	203.24	197.83	197.24	203.47	61.96	374.33

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.

* Models 1–5 GEE, model 6 random effects, and model 7 fixed effects regression results. Standard errors are in parentheses. All models include unreported year and geography effects. N = 1,299 firm-years.

Tolbert, 1997), we compared the funding-partner logics in two time periods: less-stable pre-1995 vs. more-stable post-1995 periods in the MIS device sector. We used 1995 because it is a breakpoint: the MIS procedure was a radical departure from historical surgical practice, and adoption was slow for its first decade. In fact, early on, MIS was described as a surgical heresy and a ''passing fad'' (Park and Lee, 2011). Though a few lead-user surgeons adopted the practice early, most others delayed until patients ''created the industry'' by ''demanding'' the procedure in the early 1990s (Park and Lee, 2011). Short courses were then created to train surgeons, and the first MIS courses were added to residency programs. Our interviews and sector historians documented that the MIS device sector became more stable and established post-1995. Our quantitative findings reflect this historical account. The positive influence

Table 8. GEE Negative Binomial Difference-in-differences Analysis for High-status VC vs. Other VC Funded Firms*

	Patents		Products	
Variable	Model 1	Model 2	Model 3	Model 4
Intercept	–54.13	–76.68••	247.00•••	236.41•••
	(33.84)	(36.75)	(49.78)	(51.52)
High-status VC partner		0.70••		0.07
		(0.26)		(0.31)
After treatment		0.53••		–0.16
		(0.26)		(0.33)
High-status VC partner × After treatment		0.76••		0.98••
		(0.32)		(0.44)
CVC partner	0.40•	0.22	–1.29••	–1.35••
	(0.23)	(0.25)	(0.47)	(0.46)
Government partner	0.24	0.70	0.47	0.70
	(0.56)	(0.57)	(0.76)	(0.78)
Patents			0.14•••	0.09••
			(0.03)	(0.03)
Firm age	0.00	–0.01	–0.04	–0.04
	(0.02)	(0.02)	(0.03)	(0.03)
Funding amount (logged)	0.04•••	0.02•	0.02	0.01
	(0.01)	(0.01)	(0.02)	(0.02)
Wald chi-square	65.12	162.4	76.36	92.34

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 373 firm-years.

Table 9. GEE Negative Binomial Difference-in-differences Analysis for Related CVC vs. Non-related CVC Funded Firms*

	Patents		Products	
Variable	Model 1	Model 2	Model 3	Model 4
Intercept	283.39•••	301.99•••	347.76•••	342.90•••
	(64.35)	(68.61)	(78.33)	(80.90)
Related CVC partner		0.43		–0.05
		(0.32)		(0.40)
After treatment		0.98••		–0.08
		(0.35)		(0.43)
Related CVC partner × After treatment		–1.00••		0.01
		(0.47)		(0.60)
VC partner	–0.32	–0.34	–0.66	–0.65
	(0.39)	(0.40)	(0.51)	(0.52)
Government partner	–0.25	–0.23	–2.48••	–2.48••
	(0.50)	(0.50)	(1.11)	(1.11)
Patents			0.12••	0.13••
			(0.04)	(0.04)
Firm age	0.11•••	0.08••	0.10••	0.10••
	(0.03)	(0.03)	(0.04)	(.04)
Funding amount (logged)	0.07••	0.07••	0.02	0.02
	(0.03)	(0.03)	(0.04)	(0.04)
Wald chi-square	63.36	65.03	37.71	37.88

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 143 firm-years.

Table 10. GEE Negative Binomial Difference-in-differences Analysis for NIH-SBIR vs. NIH-research Funded Firms*

	Patents		Products	
Variable	Model 1	Model 2	Model 3	Model 4
Intercept	–58.38	–126.86	–173.72	159.03
	(79.97)	(106.31)	(141.55)	(228.30)
NIH-SBIR partner		–0.39		1.74•
		(0.44)		(0.90)
After treatment		–0.84•		–0.49
		(0.43)		(0.94)
NIH-SBIR partner × After treatment		0.56		0.97
		(0.55)		(1.04)
VC partner	–0.20	–0.29	–1.60••	–1.31•
	(0.38)	(0.40)	(0.61)	(0.68)
CVC partner	0.78•	0.70•	–0.09	–0.04
	(0.41)	(0.41)	(0.75)	(0.77)
Patents			0.16•	0.17•
			(0.08)	(0.09)
Firm age	–0.02	–0.02	–0.03	0.01
	(0.04)	(0.04)	(0.07)	(0.08)
Funding amount (logged)	0.04	0.06•	–0.01	0.00
	(0.03)	(0.03)	(0.04)	(0.05)
Wald chi-square	17.70	20.08	40.15	39.61

• $p < .10$; ••$p < .05$; •••$p < .001$; two-tailed tests.
* Standard errors are in parentheses. All models include unreported year and geography effects. N = 96 firm-years.

of the VC logic on commercial innovation becomes more pronounced during this later stable period, reinforcing our main findings. Institutional influences seem stronger as environments stabilize.

Scope conditions: Logic combinations. Though our primary analyses focused on each partner type while holding the effects of other partners constant, we analyzed whether institutional logics clash when young firms received funding from multiple types of funding partners, as research suggests that incompatible logics may hurt venture performance (Battilana and Dorado, 2010). Over half of our VC-funded ventures formed a CVC tie, and one in ten had both VC and NIH ties. Our main results held in these sensitivity tests, but they also indicated that simultaneous VC and NIH funding (i.e., partners with very different institutional logics: Pache and Santos, 2010) lower both technical and commercial innovation. In contrast, simultaneous VC and CVC funding increased technical innovation. One reason may be that the professional and corporate logics complement each other with appropriate checks and balances (Hallen, Katila, and Rosenberger, 2014) and so reward hybridization of institutional logics. In contrast, professional and state institutional logics create too many conflicting demands that decrease innovation.

We also considered logic combinations that occur over time due to temporal preferences. For example, perhaps NIH invests earlier, in riskier ventures (Wallsten, 2000). If so, its ability to influence innovation could be systematically different from partner types that act later. To assess this, we examined the funding histories of each firm. We found that some firms took government funding before turning to VCs and CVCs, while others took VC funding and then turned to the government later. Some firms never received funding at all, while other firms took funding from only one partner type. In all, we found that ventures pursued a variety of funding strategies, many of which avoided VCs (see also Chatterji, 2009, for similar findings), and that there is no pattern of early investment such as by NIH or VCs or late investment such as by CVCs. Thus it is unlikely that timing differences explain our results. An interesting future path is to examine whether a particular temporal order of co-investors makes a difference and how entrepreneurs in general deal with these competing logics and the associated demands.

DISCUSSION

Our central insight is that the institutional logic of partners can influence the innovation of new firms. By studying the population of MIS device ventures since the sector's inception, we observed that ties with particular types of funding partners lead to major innovation differences even when the partners offer relevant resources, are highly selective, and have incentives to encourage innovation. So although prior research has examined alters with the same institutional logic, our work points to differences in the institutional logics of partners that influence the interactions and outcomes of ties with young firms.

A key finding is that ties with venture capitalists are particularly effective. Influenced by professional norms for deep engagement with client-entrepreneurs by highly skilled professionals, and strong identity as professional advisors for business skills, venture capitalists actively and even aggressively work with their entrepreneurial partners to achieve product innovations. This is further enhanced by institutionalized practices like staged financing, board seats, and ten-year funds that address venture capitalists' professional obligations to investors. These and other attributes, such as decision-making autonomy consistent with being a professional and simplicity of the partnership organizational structure, represent a professional institutional logic. Collectively, these attributes ensure ready access to VC resources such that entrepreneurs and their commercial innovation efforts benefit.

By contrast, ties with CVCs are much less effective. A key insight is that, consistent with the corporate institutional logic, corporations rely on a complex division of labor and strategic goals to succeed, such that cooperation is challenging and decision-making authority is dispersed. This dispersed structure and the identity of corporate venture capitalists as scouts who support corporate growth (not venture growth) mean that business unit executives often do not value assisting new firms as a priority. As a CVC executive we interviewed noted, ''In an engineering organization, the first reaction is 'We can do that. Give us a budget and we'll go build one.' . . . So in corporate settings the business units may not quite buy into what you [as the CVC] are doing.'' CVC executives also believe that they need to create distance between themselves and the venture, which keeps them off ventures' boards and makes them more passive, distant, and less-influential partners. These and other attributes create a coherent corporate logic but one that is less likely to channel the resources, mentoring, and discipline needed for ventures' innovation.

Finally, ties with the NIH are a particularly striking example of how a partner's institutional logic can restrain resource access even when those resources are significant and access is mutually beneficial. Influenced by their identity as mentors who promote fair and widespread access to public funds, NIH program officers emphasize the active selection of new firms but are then passive during the relationship. A potential consequence of an extreme emphasis on selection could be that entrepreneurs may already have all the technical results they hope to get when they receive funding for a specific project, meaning that little technical innovation occurs during the relationship because it is hard to go back to exploration and push further when, as one grantee said, it "feels like the work has already been done."

In addition, though a state logic involves fair and democratic access to resources, it also leads to a cookie-cutter approach during relationships, such as one-size-fits-all conferences in which entrepreneurs learn in lock-step. If entrepreneurs want tailored access to the NIH's immense resources, they have no path. One entrepreneur told us that because her NIH program officers became so passive during relationships, she was "unsure of the actual power" that these officers held. Consistent with Sine, Mitsuhashi, and Kirsch (2006), she suggested that such uncertainty about who is in charge and who can provide NIH resources impeded her development efforts. Similarly, funding geographically diverse ventures in many congressional districts makes sense in a state logic but also makes the effective, hands-on engagement of venture capitalists unlikely. The norms of science add to the passivity during relationships because of the attendant belief that autonomy fuels scientific discovery. These and other attributes, such as bureaucratic rules like rigid expense categories (Wessner, 2008), project (not firm) funding, and merit-based expert panels, create a coherent state logic, but they also make the NIH a passive partner such that ventures have difficulty accessing the NIH's impressive resources. Thus although we expected that the NIH's approach of highly autonomous entrepreneurs would encourage scientific discovery and greater technical innovation, our findings indicate that it does not.

Institutional Theory: More than Incentives, Resources, and Power

We contribute to institutional theory by extending the domain of institutional logics to partners in a relationship. Prior research shows that institutional logics affect the activities and outcomes of focal organizations (Marquis and Lounsbury, 2007; Thornton, Ocasio, and Lounsbury, 2012). By studying partnerships in an ideal setting in which organizations with mature institutional logics interact with new firms with nascent logics and limited power, we extend institutional theory. We show that the institutional logics of types of organizations can influence the outcomes of their partners, not just their own outcomes. Though prior work on institutions and young firms has focused on larger societal logics and their influence on ventures (Eisenhardt, 1988; Thornton, 2004), our contribution is to show how a logic represented by a particular class of institutional actors (i.e., type of partner) is significantly related to young firms' choices and outcomes.

There are, however, alternative explanations. One is that simpler concepts such as resources or incentives can explain the results. Though simpler concepts are appealing, they are not sufficient explanations. For example, CVCs in principle have access to substantial resources to improve the commercial and technical innovation of new firms. These resources may even be superior to those of VCs in many situations. Yet the various attributes of the corporate institutional logic, such as dispersed business units, fragmented authority, and long time horizon, impede access to those resources and, for related CVCs, particularly heighten the danger of misappropriating intellectual property (i.e., ''swimming with sharks'') and so limit mutual interest in deep engagement. Thus institutional logic provides a more accurate prediction than simpler concepts like resources and is consistent with the decline of CVC units that is empirically observed (Gaba and Dokko, 2015).

The incentives of funding partners could also be an alternative explanation, but our data suggest that something more than incentives alone is driving our results. For example, NIH-SBIR has a congressional mandate to encourage the commercial innovation of ventures based on their technical innovations, so it uses staged grants to achieve these outcomes and encourages reporting of both patents and products. In other words, NIH-SBIR has incentives to encourage both types of innovation. Yet its state logic impedes the ability of NIH program officers to engage in the hands-on, venture-specific behaviors that venture capitalists effectively use to achieve innovation. Though the hands-off approach may work for basic university science, it is ineffective for the commercial innovation that is central to the mission of NIH-SBIR and is even less effective than the approach of other types of funding partners for technical innovation.

Declining incentives of new firms to innovate as they gain funding partners could also be an alternative explanation, but again it seems insufficient. The corporate governance literature suggests that when employee ownership is diluted and transferred to distant outsiders, executives become more motivated to build personal empires and less motivated to develop technology (Kim, Kim, and Lee, 2008; Aghion, Van Reenen, and Zingales, 2009). But though such incentives may arise in established corporations, they are less germane to new firms. As innovation is at the heart of ventures' success—rather than being an option or an after-thought—and ventures are typically resource-constrained (Baker and Nelson, 2005), empire building without innovation seems unlikely. Our empirical tests further confirmed that reduced incentives related to diluted equity as new funding partners are added is an unlikely explanation alone. Government partners typically do not take an equity share like CVCs and especially VCs do, so we would expect the potential negative effect of ownership dilution on innovation to be strongest for VC-funded firms and weakest for the NIH-funded firms. Instead, our results show the opposite.

A related incentives explanation is that perhaps ownership of technologies, rather than ownership of the entire firm, explains reduced innovation. This could be the case in project-based funding by the government, for example. But our data do not support this explanation: all technical inventions in our sample were owned and patented by the venture, and only 2 percent of these inventions were co-assigned to a public entity. Our interviews also confirmed that there is no pattern of state ownership of MIS technologies. Another incentives explanation is that perhaps VC-funded entrepreneurs have more incentives to innovate because venture capitalists monitor them more, thus possibly explaining why their ventures achieve more innovation. Using a test developed by Aghion and colleagues (2009), we found that this explanation also does not fully explain our findings: market competition (and its related discipline) should substitute for VC-driven monitoring over time, but we found the opposite—that VC influence on innovation intensifies over time. These arguments and analyses support a more complex explanation attributable to differences in the institutional logics of funding partners rather than simply incentives as an explanation of our findings.

Another alternative explanation is power. For example, high-status VCs are often powerful, even autocratic, and so better able to influence ventures than other types of funding partners. But though these power differences are likely to exist, they are largely attributable to differences in institutional logics. Thus a key reason venture capitalists are so powerful is that they are local equity investors who have board seats and engage in frequent interactions with entrepreneurs. In contrast, both the NIH and CVCs are constrained from these activities by their institutional logics. For example, the NIH purposefully funds projects throughout the U.S. and does not take equity, thus limiting their power over ventures. Our findings indicate that institutional logic captures a configuration of attributes that more accurately describes interactions between partners and better predicts ventures' innovation than simpler constructs such as resources, incentives, and power.

Finally, some partner types may have better foresight about which ventures will be innovative (beyond what we controlled for), and they may use this foresight in making their funding decisions. But given their specialized technical, engineering, and market expertise, which typically exceeds that of the VCs, we would expect that corporate and possibly government investors would have such foresight, instead of VCs. So the foresight explanation is not fully compelling. In addition, because our setting includes the FDA as a key gatekeeper in the product approval process, VC partners' foresight about which products will become commercial successes, as suggested by Stuart, Hoang, and Hybels (1999), is an unlikely explanation. Indeed, our empirical data show no significant differences in the investment opportunities of VCs relative to other investors.

We began by asking how types of funding partners might influence the innovation that is at the heart of venture success in technology-based sectors. We found that all types of funding partners are not created equal. Though all partner types similarly select technically innovative ventures, they differ in their treatment after a tie is formed. This means that entrepreneurs should generally focus first on creating innovations to obtain funding. Because VCs, CVCs, and the NIH select ventures based on the venture's patents, technical innovation creates funding flexibility. But the path to commercial innovation and ultimately revenue is different after the funding partner relationship is established—i.e., ventures with ties to venture capitalists move more effectively down that path. Ties with the U.S. government may even impede technical innovation, meaning that ironically for entrepreneurs, the least-expensive funding with the fewest strings may be most limiting for long-term innovation success.

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