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REPUTATION AND DECISION MAKING UNDER AMBIGUITY: A STUDY OF U.S. VENTURE CAPITAL FIRMS' INVESTMENTS IN THE EMERGING CLEAN ENERGY SECTOR

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This study examines the role of reputation on decision making under ambiguity. Drawing on social cognition and behavioral theories, we propose that a firm's reputation exerts dual pressures on its decision making under ambiguity. On the one hand, a firm's reputation increases its aspirations for future performance and promotes its engagement in risky strategies to achieve them. On the other hand, preserving the already established reputation requires a firm to deliver consistent performance over time, which promotes greater use of risk reduction strategies. Our analyses of the U.S. venture capital firms' investments in the clean energy sector from 1990 to 2008 demonstrate that while reputable firms are more likely to invest in the emerging sector, they also employ risk reduction strategies more extensively. The sector's legitimation further influences these firms' investment decisions both directly and through its interaction with firm reputation.

The role of reputation—i.e., stakeholders' perceptions of a firm's ability to deliver value along key dimensions of performance (Rindova & Fombrun, 1999; Rindova, Pollock, & Hayward, 2006)—in stakeholders' decisions and actions towards the firm is well understood by scholars and practitioners alike (Fombrun, 1996). Prior research shows that a firm's reputation influences the decisions of customers (Jensen & Roy, 2008; Rindova, Williamson, Petkova, & Sever, 2005), investors (Pfarrer, Pollock, & Rindova, 2010), alliance partners (Dollinger, Golden, & Saxton, 1997), and employees (Turban & Cable, 2003; Williamson, Cable, & Aldrich, 2002) to interact with it and to provide it with resources or other support (Rindova et al., 2005). However, the role that a firm's reputation plays in its own decision making has received surprisingly little research attention.

To the extent that prior research speaks to this issue, it focuses primarily on the recursive relationship between reputation and performance, arguing that firms protect their reputations by persisting with a selected course of action (Clark & Montgomery, 1998; Weigelt & Camerer, 1988) in order to deliver consistent performance over time (Fombrun & Shanley, 1990; Ippolito, 1992; Pfarrer et al., 2010). Whereas this research portrays reputable firms as conservative in their decisions by empha-

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sizing pressures to protect their already-established reputations (Pfarrer et al., 2010), studies of reputation-damaging events, such as negative publicity (Elsbach, 1994), product recalls (Rhee, 2009; Rhee & Haunschild, 2006), and corporate illegality (Mishina, Dykes, Block, & Pollock, 2010), suggest that stakeholders develop particularly high expectations of reputable firms. These studies also indicate that maintaining consistent performance may not be enough to meet these expectations (Mishina et al., 2010; Wade, Porac, Pollock, & Graffin, 2008) and that reputable firms sometimes depart from the performance-maintenance path in search for new, and potentially riskier, opportunities to increase performance. Together, these bodies of research suggest that reputation exerts dual pressures on a firm's decisions. Yet they stop short of exploring the tensions between them and addressing under what conditions, and to what extent, each pressure exerts influence.

Our study takes a step towards addressing these gaps in prior research by articulating the mechanisms through which the dual pressures of reputation affect a firm's decision making and by examining how they operate under conditions of ambiguity. Drawing on social cognition and behavioral theories, we propose that reputation increases a firm's aspirations for future performance, which in turn trigger exploration of new, and potentially riskier, opportunities to meet the ever-growing expectations of stakeholders (Mishina et al., 2010). At the same time, pressures to preserve their already-established reputations compel reputable firms to engage in strategies that ensure consistent performance outcomes (Pfarrer et al., 2010; Rhee, 2009).

Further, to understand how firms balance the tensions created by these pressures, we focus on decision making under conditions of ambiguity. Ambiguity—defined as the "lack of clarity about the meaning and implications of particular events or situations" (Santos & Eisenhardt, 2009: 644)—is typically experienced in contexts characterized by "novelty, complexity, or insolubility" (Budner, 1962: 30). Unlike conditions of uncertainty, under which decision makers can recognize and assess the desired outcomes and the means to achieve them, but cannot predict the probability of a specific outcome (Weick, 1995), in ambiguous situations decision makers lack even the understanding of which outcomes are worth pursuing (Garud & Van de Ven, 1992), let alone how to achieve them (March & Olsen, 1976; Starbuck & Milliken, 1988). The inability to identify decision-relevant factors and cause–effect relationships among them (Ball-Rokeach, 1973: 379) makes it difficult for decision makers to envision the outcomes of a given action (Garud & Van de Ven, 1992; Miller, 2012). Thus ambiguity provides a vast range of possibilities for forming expectations—both in terms of opportunities and threats (March & Olsen, 1976)—and makes salient not only the pressures for maintaining consistent performance identified in prior research, but also the need to search for new business opportunities. The emergence of new technologies and markets increases the chances that organizations will face ambiguous contexts (Miller, 2012; Santos & Eisenhardt, 2009); understanding the role of a firm's reputation in its decision making under ambiguity is therefore of primary theoretical importance.

Extant reputation research relies on the existence of shared understanding and agreement on the relevant dimensions of performance along which firms are compared as stakeholders form reputational perceptions about them (Lange, Lee, & Dai, 2011; Rindova et al., 2005). As a result, it ignores the possibility for multiple conflicting interpretations typical under conditions of ambiguity (Garud & Van de Ven, 1992; March & Olsen, 1976). Thus our focus on the role of reputation in decision making under ambiguity allows us to gain new insights into the mechanisms through which reputation influences the interpretation of situations in which shared understanding is lacking.

We examine how the dual pressures of reputation operate within the context of venture capital (VC) firms' investment decisions in relation to an emerging sector. This context offers two main benefits: First, prior research highlights the significant role that reputation plays in major VC investment decisions, such as at the investment stage (Dimov, Shepherd, & Sutcliffe, 2007), at syndication (Dimov & Milanov, 2010; Sorenson & Stuart, 2001), and the timing of taking portfolio companies public (Gompers, 1996; Lee & Wahal, 2004). The importance of reputation in VC decision making increases our ability to observe theoretically relevant relationships and outcomes. Second, an emerging sector exemplifies extreme ambiguity (Santos & Eisenhardt, 2009) owing to the fluid nature of its boundaries, structure, and participants (Aldrich & Fiol, 1994), the lack of agreement on criteria for product quality or performance (Hargadon & Douglas, 2001; Rindova & Kotha, 2001; Rosa, Porac, Runser-Spanjol, & Saxon, 1999), and the absence of fundamental understanding of the cause–effect relationships

and factors leading to success (Kaplan & Tripsas, 2008; Porac, Ventresca, & Mishina, 2002). The ambiguity surrounding an emerging sector creates multiple possibilities for interpretation by interested actors (Rosa et al., 1999), whose interpretations can range from envisioning great strategic opportunities to foreseeing fatal consequences. We propose that the inability to predict the outcomes of potential involvement with the emerging sector triggers reputational considerations that lead to systematic differences among VC firms in their investment decisions.

Further, we draw on legitimacy theory to articulate the effects of the legitimation of an emerging sector on the decisions of the VC firms contemplating investment in it. Whereas prior research has established the relationship between reputation and legitimacy at the firm level of analysis (Deephouse & Carter, 2005; Rao, 1994), it overlooks the possibility that the legitimation of an emerging sector may affect decision makers differently depending on their own reputations. Our study addresses this gap by examining the effects of the sector's legitimation on VC decision making both directly and through its interaction with the VC firms' reputation.

Our analyses of the U.S. VC firms' investment decisions regarding the emerging clean energy sector from 1990 to 2008 show that reputation increases a VC firm's likelihood to invest in the emerging sector, but also leads to greater use of risk reduction strategies. Sector legitimation influences these relationships both directly and through its interactions with reputation. By studying the effects of reputation on a firm's decision making under ambiguity, this study responds to a call for organizational research addressing how reputation affects the behavior of the firms possessing it (Pfarrer et al., 2010: 1145). Further, our study offers new insights to reputation and legitimacy research by demonstrating the effects of sector legitimation on firms with different reputations.

THEORY DEVELOPMENT AND HYPOTHESES

Ambiguity and the VC Decision Making Process

When making investment decisions, VC firms always face some uncertainty about the quality and potential of entrepreneurial startups, because the resources, activities, and business models of such organizations are not fully developed (Petkova, Rindova, & Gupta, 2013; Rindova & Kotha, 2001). To address this uncertainty, VC firms devise indicators of startup "potential," such as entrepreneurial, human, and social capital (Baum & Silverman, 2004; Hallen, 2008; Hsu, 2007), quality of the product idea, and the risk–return profile of the market (Gompers & Lerner, 1999). Although VC firms may differ in their access to "high-quality" investment opportunities (Hsu, 2004), they typically share a common understanding of the relevant criteria for judging the startups in an established sector.

However, when considering investments in an emerging sector, VC firms not only face uncertainty about the quality and potential of a particular startup (i.e., the likelihood that the startup turns out to be a "high performer"), but also lack the fundamental understanding of how to think about quality and potential in the sector (i.e., what constitutes "high performance" in this context). The following statement by a VC investor in clean energy whom we interviewed illustrates this challenge: "One can argue that Tesla, Bright Source, and Solar City are some of the leading clean tech companies, but you just don't know. I think that one of the main challenges with clean tech is that you don't know."[1]

In the context of clean energy, the VC investors whom we interviewed also noted the ambiguity about capital intensity, investment time frame, and feasible exit mechanisms. As one VC investor explained:

> Most IT folks want to get out in five to seven years; clean tech takes seven, ten, or more. That's what we all want to say, but the reality is that you're in there for a lot longer. You're in there for a lot longer, you're putting in more money, and you're not rewarded for the long timeline. And the exits are unclear.[2]

These quotes illustrate a key problem that prospective VC investors in an emerging sector face: the lack of adequate frameworks to evaluate startups. The multiple interpretations of the meaning, value, and usefulness of new activities, products, and business models create confusion (Aldrich & Fiol, 1994; Hargadon & Douglas, 2001; Lounsbury, Ventresca, & Hirsch, 2003), and make it difficult for

[1] We conducted semi-structured exploratory interviews with 13 VC investors in clean energy startups to better understand the nature of ambiguity experienced by VC decision makers when considering an emerging sector.

[2] See n. 1.

sector participants to understand and articulate the factors of success in this context (Rindova, Petkova, & Kotha, 2007; Rosa et al., 1999). Unlike familiar sectors in which VC firms share a common understanding of the criteria for judging startup quality and potential (Baum & Silverman, 2004), the ambiguity in an emerging sector leaves significant room for interpretation, and VC firms can vary both in their assessment of the (un)attractiveness of the emerging sector and in the selection criteria that they consider relevant. In the next section, we discuss how the investment decisions that a VC firm makes under these conditions are systematically affected by its reputation.

The Dual Pressures of Firm Reputation

Reputation reflects stakeholders' perceptions of a firm's ability to deliver value along key dimensions of performance (Rindova et al., 2006; Rindova & Fombrun, 1999), such as product quality (Rhee & Haunschild, 2006; Rindova et al., 2005) and financial results (Fombrun & Shanley, 1990; Pfarrer et al., 2010). These perceptions are based on the firm's demonstrated ability to create value—a characteristic that distinguishes reputation from other related constructs, such as celebrity, status, and legitimacy (Pfarrer et al., 2010; Rindova et al., 2006). Studies of VC firms' reputation focus specifically on their ability to deliver consistent returns on investment (Dimov et al., 2007; Lee, Pollock, & Jin, 2011), which plays a critical role in stakeholder perceptions and affects VC firms' subsequent ability to raise funds (Gompers, 1996; Lee & Wahal, 2004). VC firms build reputation by carefully selecting startups for funding (De Clercq, Fried, Lehtonen, & Sapienza, 2006; Sapienza & Gupta, 1994), by mentoring and monitoring those startups' development (Pollock, Chen, Jackson, & Hambrick, 2010; Sapienza, 1992), and by ensuring successful exit, preferably through an initial public offering (IPO) (De Clercq et al., 2006). Overall, research on VC firms' reputation fully supports the notion that reputation exerts pressures towards consistent performance (Ippolito, 1992; Pfarrer et al., 2010).

However, recent studies of reputation-damaging events, such as product recalls (Rhee, 2009; Rhee & Haunschild, 2006) and corporate illegality (Mishina et al., 2010), suggest that stakeholders tend to develop particularly high expectations of reputable firms and that ensuring consistent performance over time may not be enough to meet such expectations (Mishina et al., 2010; Wade et al., 2008). Further, pressures towards consistent performance do not explain the bold and risky strategic moves of highly reputable firms that have departed substantively from their proven strategies, such as Google's development of a driverless car or Apple's introduction of mobile and entertainment devices. To account for the possibility that reputation exerts pressures towards departure from the performance-maintenance path, we theorize an alternative mechanism through which reputation influences decision making under ambiguity. We propose that the expectations that stakeholders form for reputable firms raise these firms' aspiration levels; higher aspirations, in turn, motivate reputable firms to interpret an ambiguous situation as a worthwhile opportunity to explore.

Reputation, Aspirations, and Decision Making under Ambiguity

Aspirations reflect "desired performance levels in specific organizational outcomes" (Shinkle, 2012: 416). They serve as reference points when judging the acceptability of strategic alternatives (Fiegenbaum, Hart, & Schendell, 1996; Wiseman & Gomez-Mejia, 1998) by determining whether an alternative is framed as a potential gain or loss (Kahneman & Tversky, 1979). Aspirations depend on a firm's historical performance, social comparison to its peers, and/or expectations among investors and other stakeholders (Cyert & March, 1963; Greve, 1998; Grinyer & McKiernan, 1990), and can be adjusted over time as firm performance changes (Greve, 2002; Lant, 1992). Firms with high aspirations often recognize that their current strategies may not allow them to achieve these aspirations and search for new, and often riskier, strategies to increase performance (Bromiley, 1991; March & Shapira, 1987). High aspirations are found to trigger inherently risky strategic moves, such as entering new markets (Greve, 1998), creating corporate VC units (Gaba & Bhattacharya, 2012), and engaging in illegal activities (Mishina et al., 2010).

Reputation indicates the extent to which stakeholders perceive a firm as being able to meet their needs by providing greater value than competitors (Deephouse & Carter, 2005; Rindova et al., 2005). Although such perceptions lead to favorable decisions and actions by stakeholders (Lange et al., 2011), they can also make stakeholders form very high and sometimes unrealistic expectations of the firm's future performance (Mishina et al., 2010; Rhee & Haunschild, 2006; Wade et al., 2008). For

example, reputation increases customers' expectations of product quality (Rhee, 2009; Rhee & Haunschild, 2006) and makes investors overly optimistic about the stock of reputable firms (De Bondt & Thaler, 1990; La Porta, 1996). Such expectations put pressure on reputable firms to raise their aspirations for future performance (Grinyer & McKiernan, 1990; Mishina et al., 2010).

In the VC context, limited partners—i.e., private and institutional investors who provide capital to the venture funds—are particularly likely to develop high expectations about VC firms' performance, because they expect greater return on investment than they could obtain from the stock market (De Clercq et al., 2006). Because reputable VC firms presumably possess better ability to provide such returns (Gompers, 1996; Lee & Wahal, 2004), reputation is of primary consideration when limited partners choose to entrust their money in the hands of a given firm. As a result, reputable VC firms are under pressure to meet the ever-growing expectations of their stakeholders.

Pressures to meet high stakeholder expectations in turn are likely to raise the aspirations of reputable VC firms and to make them seek new opportunities to enhance future performance. To the extent that aspirations affect managerial interpretations of threats and opportunities (March & Shapira, 1987), reputable VC firms are more likely to perceive an ambiguous, emerging sector as a promising source of new investment opportunities. If the sector turns out to be the "next big thing," early investors can generate lucrative financial returns, as illustrated by the success of early VC investments in computers and Internet-based technologies (e.g., Apple, eBay, Google). For example, eBay—one of the best-performing VC investments in history—provided Benchmark Capital with a return of about 1,000 times its initial investment (Swensen, 2000). The desire to discover the "next big thing" is a powerful motivator for reputable VC firms to channel their investments towards emerging sectors such as clean energy. Along these lines, John Doerr, general partner at Kleiner Perkins Caufield & Byers, explains his rationale for investing in clean energy as follows:

> The only way we're going to accomplish what we want to accomplish, in the form of new energy and clean energy, is relying on private capital markets. . . . Now I believe, as a red-blooded American capitalist, we just can't sit back and let the next great global industry not be developed. (Murray, 2010)

Getting involved with the potential "next big thing" appears to be a more important consideration than understanding the dynamics of the emerging sector or being able to estimate the potential returns on investment from it. This notion also came up in our interviews with reputable VC investors, who emphasized the importance of investing in emerging technologies. According to one VC investor:

> Well, you're building an entirely new industry . . . So, you can get excited about the potential . . . we typically try not to invest in anything that's just going to move the needle a little bit, but that is going to be a completely revolutionary . . .[3]

As these quotes illustrate, high aspirations may lead reputable VC firms to search for the "next big thing" and to perceive an emerging sector as a potential source of lucrative investment opportunities.

In addition to raising stakeholder expectations and firm aspirations, reputation also enables firms to act towards achieving their elevated goals. Reputation improves VC firms' ability to raise funds (Dimov et al., 2007; Dimov & Milanov, 2010) and increases the availability of slack resources to explore new opportunities (Garud & Van de Ven, 1992; Levinthal & March, 1981; March & Shapira, 1992). Also, reputable VC firms tend to attract more startups seeking funding (Hsu, 2004), which gives the VC firms greater exposure to new investment opportunities and increases their chances of investing in an emerging sector. Overall, reputation increases stakeholder expectations and raises VC firms' aspirations, which motivates them to search for new ways in which to increase performance. High aspirations, coupled with superior access to resources and startups, increase the likelihood that reputable VC firms will invest in an emerging sector. We therefore hypothesize that:

> *Hypothesis 1. The higher the reputation of a VC firm, the higher the likelihood that it will invest in an emerging sector.*

Reputation and Pressures for Consistent Performance

The second mechanism through which reputation influences firm decision making is by putting pressure on firms to perform consistently over time (Ippolito, 1992; Pfarrer et al., 2010). Given that it is both costly and time-consuming to develop high

[3] See n. 1.

reputation (Dierickx & Cool, 1989), firms that succeed in doing so typically persist with their selected course of action (Clark & Montgomery, 1998; Weigelt & Camerer, 1988) in order to ensure consistent performance and to send stakeholders clear signals about their strategies and ability to create value (Fombrun & Shanley, 1990; Rindova et al., 2005), thus maintaining and protecting the reputation that they have secured.

Under ambiguity, however, decision makers are not sure what outcomes to expect (Garud & Van de Ven, 1992), let alone how to ensure the desired level of performance (Miller, 2012; Starbuck & Milliken, 1988). Knowledge accumulated through prior experience is usually inapplicable to such conditions (Kahneman & Klein, 2009), which hinders a firm's ability to devise a course of action that ensures consistent quality or financial performance. Thus the risk of misperceiving an opportunity and making poor decisions is much greater, and the potential negative consequences, including reputation damage, cannot be ignored. As one VC investor in clean energy noted:

> I think we all believe that there will be enough kind of hype in the market to give these companies a great exit. But when you're pouring $100 to $200 million into some of these clean tech companies before you can get them to IPO stage, to get your money back you have to believe that they're going to be sold for a billion, right? . . . And so if we're wanting that, do we know that Bright Source will be valued at a billion dollars? Do we know that Tesla is going to go out of the market at two billion? We don't . . .[4]

The VCs who decide to invest in an emerging sector are certainly not naive investors who myopically believe in their ability to predict the future. They are well aware of the high level of risk related to such investments, which may turn out to be far less rewarding than expected and may fail to bring the desired (or any) returns on investment. For example, some promising emerging technologies that have received VC investments, such as radio-frequency identification (RFID) (Denne, 2007), quantum computing, and nanotechnology (Bradley, 2009), have not gained sufficient market traction to generate adequate returns. The risks of investing in an emerging sector are particularly salient to firms with high reputation, because such firms experience preponderant pressures to deliver consistent performance (Mishina et al., 2010; Pfarrer et al., 2010) and incur greater reputation damage if unable to meet stakeholder expectations (Rhee & Haunschild, 2006). Although investing in an emerging sector per se is unlikely to hurt a VC firm's reputation, because risky investments are the norm in the VC industry (Gompers & Lerner, 1999), involvement with the emerging sector may have substantive reputational implications when there is enough evidence that the sector has taken off and provided lucrative returns or, on the flip side, has turned out to be unsuitable for VC investment.

Risk perceptions are highly subjective in the absence of clear criteria and standards to guide decision making (Fiske & Taylor, 1991), and are typically associated with the "costs" of being wrong (Freund, Kruglanski, & Shpitzajzen, 1985; Tetlock, 1983). An already-established reputation increases the costs of being wrong in terms of reputation damage, because developing reputation is a costly and time-consuming process and damage to reputation is worse for those reputable firms (Rhee & Haunschild, 2006) of which stakeholders have higher expectations (Mishina et al., 2010; Wade et al., 2008). For example, failure to deliver the returns expected threatens a VC firm's reputation among its limited partners who expect high returns on investment within a reasonable time frame (De Clercq et al., 2006; Dimov & Gedajlovic, 2010). Therefore, even though decision making under ambiguity is challenging for any firm (Garud & Van de Ven, 1992), the more reputable firms are likely to perceive such decisions as riskier owing to the potential reputation damage they may incur.

Concerns about protecting firm reputation are likely to increase decision makers' efforts to "manage" the risk associated with their decisions (March & Shapira, 1987: 1410). Entrepreneurship research suggests that there are three risk reduction strategies available to VC firms: syndication (Dimov & Milanov, 2010; Sorenson & Stuart, 2001), later-stage investment (Dimov et al., 2007), and low levels of commitment (Wadhwa & Basu, 2013). Syndication is particularly relevant when investing in sectors in which the VC firm has less experience (Dimov & Milanov, 2010), because it reduces the investment risk that these firms take through sharing information and knowledge (Bygrave, 1987; Matusik & Fitza, 2012). Later-stage investment is appealing for VCs with less experience in a given technology or sector (Dimov et al., 2007), because later-stage startups usually need less hands-on coaching (Gupta & Sapienza, 1992; Sapienza, 1992) and do not require specific technical expertise (De

[4] See n. 1.

Clercq et al., 2006). In contrast, early-stage investments are considered riskier because selecting and mentoring an early-stage startup requires expertise in the startup's technology domain (Dimov et al., 2007; Sapienza, Manigart, & Vermier, 1996). The third risk reduction strategy—low levels of commitment (Wadhwa & Basu, 2013)—appears particularly relevant when investing in an emerging sector. We conceptualize level of commitment as the total resources, time, and effort that a VC firm commits to a given sector (Gupta & Sapienza, 1992; Sapienza, 1992), relative to its activity across all sectors in a period of time. Investing in more clean energy startups relative to startups in other sectors reflects a higher level of commitment, because VC firms not only have to provide more financial resources, but also have to spend time and effort mentoring and monitoring the startups (Baum & Silverman, 2004; Sapienza, 1992). Lower commitment reduces the risk associated with an emerging sector because it allows the VC firm to focus on familiar investment sectors.

Each of these strategies allows a VC firm to reduce the amount of risk that it takes. Although a VC firm with a higher reputation may be more likely to invest in an emerging sector driven by its higher aspirations, it is also likely to make greater efforts to manage the risks associated with such investments in order to balance the exploration of new opportunities with the pressures towards consistent performance. We therefore hypothesize that:

Hypothesis 2. The higher the reputation of a VC firm, the greater its use of (a) syndication and (b) later-stage investment, and (c) the lower its levels of commitment when investing in an emerging sector.

Sector Legitimation and VC Investment Decisions

Sector legitimation—defined as "the process of social construction of legitimacy" (Bitektine, 2011: 152) that unfolds within a nascent domain—influences the "collective structuration . . . of entire *fields* or *sectors* of organizational life" (Suchman, 1995: 576, emphasis original, citing DiMaggio & Powell, 1983). Recent work has highlighted the importance for scholars to distinguish between the state of being legitimate, which is based on the judgment of new firms, products, and technologies as conforming with institutional norms (Aldrich & Fiol, 1994), and the preceding legitimation process (or the "pre-legitimacy" stage) of new sector emergence (Colyvas & Powell, 2008; Rosa et al., 1999). This process typically takes a long time and involves multiple actors as it gradually leads to the development of sector-wide knowledge and shared understanding of the meaning of new product categories (Kennedy, Lo, & Lounsbury, 2010; Rosa et al., 1999), the boundaries and definition of relevant technological dimensions (Bijker, Hughes, & Pinch, 1987; Santos & Eisenhardt, 2009), and the validity and appropriateness of new practices (Lounsbury & Crumley, 2007; Tripsas, 2009).

Prior research suggests three main factors that facilitate the sector legitimation process and affect the actions of various stakeholders (Deeds, Mang, & Frandsen, 2004; Sine, David, & Mitsuhashi, 2007; Sine, Haveman, & Tolbert, 2005): media attention, regulatory approval, and actions of peers. Media attention to an emerging sector increases its salience and perceived importance by attracting large-scale public attention, thus placing it on the "public agenda" (Gamson, Croteau, Hoynes, & Sasson, 1992; Hilgartner & Bosk, 1988). Generating awareness about an emerging sector fits well with the goal of the media to identify and inform the public about new developments in society (Rosentiel & Kovach, 2001), because a sector is more newsworthy before it becomes "taken for granted" (Deephouse & Suchman, 2008: 54). In addition to attracting attention to an emerging sector, the media also disseminate information about it, giving prospective investors a sense of entrepreneurial activity in the sector and public sentiment towards it.

Acts of regulatory approval, such as financial incentives (Pacheco, 2009) and certifications from legal authorities (Deeds et al., 2004; Sine et al., 2007), provide foundations for structuring an emerging sector (Aldrich & Fiol, 1994; North, 1990). They signal legislators' commitment to establish the infrastructure for sector emergence and provide guidelines on the trajectories for its future development (Van de Ven & Garud, 1989). Designed to support the development of an emerging sector, such acts increase startup rates (Sine et al., 2005; Sine & Lee, 2009) and improve startups' growth and survival prospects (Deeds et al., 2004; Sine et al., 2007). Also, some regulatory acts, such as subsidies and tax incentives, stimulate demand by lowering the prices that prospective customers are likely to pay for the new products and services.

Actions of peers have also received substantial attention in prior research. An increase in the number of participants in a new domain facilitates the development of shared understanding of its char-

acteristics (Hannan & Carroll, 1992; Hannan & Freeman, 1989) and fosters the emergence of underlying social and institutional infrastructures, such as operating procedures, organizing templates, and standards (Garud, Jain, & Kumaraswamy, 2002), which contribute to the accumulation of sector-specific knowledge. Also, peers serve as "social proof" that a given course of action is viable, increasing the likelihood that other firms will follow (DiMaggio & Powell, 1983; Rao, Greve, & Davis, 2001). The highly networked nature of the VC industry facilitates diffusion of information about firms that have already invested in an emerging sector, making others less skeptical about it (Davis, 1991; Haveman, 1993). Thus, the more VC firms invest in an emerging sector, the greater the exposure of their peers to its existence as an investment opportunity.

Overall, the legitimation process plays a dual role in attracting attention to the emerging sector and facilitating the spread of information about it (Hannan, Carroll, Dundon, & Torres, 1995; Sine et al., 2005). Given that allocation of attention (Petkova et al., 2013) and information provision (Rindova et al., 2007) are critical to assessing the viability of new technologies and sectors, we expect the growing sector legitimation to influence VC firms' investment decisions positively. We therefore hypothesize that:

Hypothesis 3. Sector legitimation will increase the likelihood of a VC firm investing in an emerging sector.

In addition to increasing VC firms' awareness and interest in an emerging sector, the legitimation process is likely to reduce their risk perceptions by gradually resolving some aspects of the ambiguity surrounding the emerging sector. For example, media outlets provide a forum for "conversations" among various interested parties by featuring entrepreneurial stories (Lounsbury & Glynn, 2001), or public debates and contestations of the new organizational forms and activities (Rao, 1994). Such interactions facilitate the development of shared meaning and understanding about the emerging sector and the benefits that it may create (Rosa et al., 1999). Acts of regulatory approval can reduce the ambiguity associated with the emerging sector by creating structure and stability that facilitate startup activity and improve startups' survival rates (Sine et al., 2005; Sine et al., 2007; Sine & Lee, 2009). The growing number of peers investing in the emerging sector can further reduce the perceived riskiness of such investments in the eyes of a focal VC firm, because it serves as a social proof that the sector is worth consideration (Rao et al., 2001). Overall, as the legitimation process reduces some of the ambiguity about the emerging sector, VC firms are likely to perceive investment in it as less risky. Therefore we expect the growing sector legitimation to reduce the use of risk reduction strategies on part of VC firms that decide to invest in the sector, and we hypothesize that:

Hypothesis 4. Sector legitimation will reduce the use of (a) syndication, (b) later-stage investment, and (c) lower levels of commitment among VC firms investing in an emerging sector.

Interactions between VC Firm Reputation and Sector Legitimation

The growing legitimation of an emerging sector is a salient institutional force likely to be noticed by every VC firm. However, interpreting and incorporating complex information from the institutional environment into firm decision making depends not only on the information availability, but also on the capabilities of the decision makers. To the extent that a VC firm's reputation reflects its superior judgment and evaluation capabilities (Baum & Silverman, 2004; Hsu, 2004), reputable firms exemplify expert decision makers—defined as "those who have been recognized within their profession as having the necessary skills and abilities to perform at the highest level" (Shanteau, 1992: 255). Research in cognitive psychology shows that expert decision makers tend to use more complex information and take into account a broader range of factors related not only to the subject of their evaluations, but also to the evaluative environment (Fiske & Taylor, 1991). In the context of managerial decision making, Eisenhardt (1989) observes that expert decision makers use more complex information and make faster decisions than non-experts. Following this logic, the expertise and ability associated with reputation increase a VC firm's ability to identify and take into account relevant cues from the environment, such as the growing legitimation of an emerging sector.

Further, the growing interest of institutional investors in the emerging sector stemming from the sector's legitimation disproportionately benefits a reputable VC firm in raising new funds because its track record increases its credibility with investors (Diamond, 1989; Gompers, 1996). Whereas less rep-

utable VC firms may also be willing to invest, they are somewhat limited in their access to resources. As a firm's resource endowments shape the perceptions and judgments of its decision makers (Kraatz & Zajac, 2001), the increased access to resources resulting from the growing sector legitimation will increase the reputable VC firms' propensity to interpret the ambiguous situation as an opportunity for discovering new sources of future returns. In addition, reputable VC firms that have not yet invested in the emerging sector may feel pressure to act—or risk being left behind by those of their peers that have already invested in it (DiMaggio & Powell, 1983). Such competitive pressures, coupled with the increasing social proof (Rao et al., 2001) that the sector is worth considering, are likely to affect the decisions of those reputable VC firms that are concerned with staying ahead of the competition and discovering the "next big thing." Overall, these arguments suggest that reputable VC firms are in a better position to identify changes in their institutional environment and to take advantage of them. Therefore we expect that sector legitimation will strengthen the positive relationship between a VC firm's reputation and its likelihood to invest in the emerging sector:

Hypothesis 5. Sector legitimation will strengthen the relationship between a VC firm's reputation and its likelihood to invest in an emerging sector.

We argued earlier that reputational concerns are stronger for more reputable firms. However, with the growing legitimation of the emerging sector, its participants (including VC firms) begin to develop some shared understanding of the new technologies, activities, and business models (Bitektine, 2011; Deephouse & Suchman, 2008). Whether such understanding is correct or misguided, it is likely to reduce the (subjective) ambiguity experienced by VC firms and to alleviate their concerns about protecting their reputations by means of extensive risk-reduction strategies. *Also, as the legitimation of the emerging sector grows and more firms get involved with it, reputable VC firms may interpret this as evidence that the sector is indeed turning into the "next big thing"* (DiMaggio & Powell, 1983; Rao et al., 2001). *Such interpretations are likely to reduce a firm's risk perceptions and corresponding use of risk reduction strategies.* For example, the growing public awareness of clean energy over the past decade has led many people—including VC investors—to believe that it is indeed the "next big thing." As one VC investor in clean energy whom we interviewed stated: "VCs need to be looking for the next big wave, and a very significant number of people believe that's the case for clean tech."[5]

By alleviating the ambiguity experienced by reputable VC firms and lowering their risk perceptions, the growing sector legitimation is likely to attenuate the differences in use of risk reduction strategies between VC firms with different reputations. Therefore we expect that the sector legitimation will weaken the relationship between a VC firm's reputation and its use of risk reduction strategies:

Hypothesis 6. Sector legitimation will weaken the relationship between a VC firm's reputation and its use of (a) syndication, (b) later-stage investment, and (c) lower levels of commitment when investing in an emerging sector.

METHODS

Research Context

The U.S. clean energy sector—encompassing an eclectic set of technologies for energy generation, energy conservation, and efficiency that "harness renewable materials and energy sources or reduce the use of natural resources by using them more effectively and productively, cut or eliminate pollution and toxic wastes" (Pernick & Wilder, 2008: 2)—is a typical case of an emerging sector surrounded by ambiguity. Although modern technologies for clean energy generation, conservation, and efficiency have been under development for more than five decades, the clean energy sector is still in its infancy in terms of commercialization and market acceptance. Over the years, both the sources of clean energy and the technologies for utilizing them have proliferated, resulting in a growing number of inventions, projects for commercial applications, and startups working on them (Pernick & Wilder, 2008). However, the market has been rather slow in adopting any of the new technologies and the vast majority of startups are yet to see profitability (Ghosh & Nanda, 2010; Hargadon & Kenney, 2012). The development of the sector is further challenged by the controversy and confusion typical of new technologies (Hargadon & Douglas, 2001). For instance, windmills have been a recurrent subject of environmentalists' attacks as a potential threat to migrating birds (Bryce, 2009),

[5] See n. 1.

solar panels installed on residential rooftops have been criticized for their questionable aesthetics (Bostwick, 2010; Brown, 2008), and enhanced geothermal systems have been accused of causing seismic activity (Romano, 2009). Overall, the high level of ambiguity surrounding the clean energy sector and its relatively slow "emergence" over the past decades provides an excellent context for examining VC decision making under ambiguity.

Data and Variables

We tracked all investments made by U.S.-based VC firms in clean energy startups from 1990 to 2008.[6] We selected 2008 as the last year, because the incentives that the Obama administration expanded in 2009 substantively changed the dynamics of the sector. We assume that any VC firm could potentially invest in the clean energy sector and included in our study the entire population of 3,574 VC firms that made an investment in any sector during the observation period. We included each VC firm in the panel for each year starting from 1990 or the year of its founding (if founded after 1990) until one of the following events occurred: (a) the VC firm made an investment in a clean energy startup; (b) the VC firm was inactive (made no investments) for five consecutive years, at which point we assumed it was discontinued; or (c) we reached the end of 2008. This approach yielded 37,293 firm-year observations. For testing the theorized effects of VC firm reputation and sector legitimation on the use of risk reduction strategies, we constructed a second panel consisting of the 172 VC firms that invested in 181 unique clean energy startups during the observation period. We tracked these VC firms annually from the year in which they first invested in clean energy until the end of 2008. This resulted in a total of 709 firm-year observations.

Following prior research (e.g., Dimov & de Holan, 2010; Dimov et al., 2007; Lee et al., 2011), we obtained the data on all VC firms and their investments from the VentureXpert database. We used the startup industry indicated in VentureXpert in order to identify the clean energy investments. The rest of the data were collected from the Earth Policy Institute (http://www.earth-policy.org/), the U.S. Department of Energy (http://www.energy.gov/), the Lexis Nexis Academic database, and the Database of State Incentives for Renewables and Efficiency (DSIRE, http://www.dsireusa.org/).

Dependent Variables

Likelihood to invest in the emerging sector. This variable takes a value of 1 if the focal VC firm invested in at least one clean energy startup and 0 otherwise. Out of the total population of 3,574 VC firms, 172 (4.8%) invested in clean energy for the first time during our observation period. As a robustness test, we repeated the analysis for the 104 VC firms whose first clean energy investment was made in the first round of the startup company. All results remain consistent.

Risk reduction strategies. We operationalize the three risk reduction strategies as follows. Consistent with prior research (Dimov & De Clercq, 2006), we operationalize *use of syndication* as the average number of syndicate partners (i.e., the VC firms with which the focal VC firm co-invested) in all of the rounds of its clean energy investments in the focal year. *Use of later-stage investments* is operationalized as the average stage of the clean energy startups in which a VC firm invested in the focal year. We operationalize *level of commitment* as the number of clean energy startups funded by a focal VC firm in a given year divided by the total number of startups the VC firm funded in that year (Wadhwa & Basu, 2013). Only the first-time investments by the focal VC firm in each startup were included in these calculations. This variable ranges from 0 to 1. As a robustness test, we also collected data on the annual dollar amount invested in clean energy startups by each VC firm as a proportion of the amount invested by that VC firm in its entire portfolio for that year (Wadhwa & Basu, 2013). These data were available for only 321 of the 709 firm-year observations (45%). For these observations, the correlation between the two proportions is $r = 0.81$, suggesting that financial commitment is a substantive part of VC firms' overall commitment to the emerging sector.

[6] We identified 11 investments in clean energy startups prior to 1990 (1962–1989). Owing to missing variables and inconsistent data-reporting in VentureXpert before 1990, we could not include these years in our analysis. The few VC firms that invested prior to 1990 were included when computing the reputation and status variables, but not considered at risk of investing because they already had invested prior to the beginning of our observation period.

Independent Variables

VC firm reputation. To capture the distinct basis of reputation in firm demonstrated ability to create value (Pfarrer et al., 2010; Rindova et al., 2005), we use the composite VC reputation index developed and validated by Lee et al. (2011). Unlike studies that use only one or two indicators that serve as "a rough proxy capturing one dimension of a VC firm's reputation" (Lee et al., 2011: 40), the VC reputation index captures both the quality and prominence dimensions of reputation (Rindova et al., 2005). Further, it "increases the reliability of the measure and reduces the effects of random error, thereby generating estimates that are closer to the 'true value'" of the reputation construct (Lee et al., 2011: 40). To the best of our knowledge, this is the most advanced measure of VC firm reputation developed to date and the only one that captures both dimensions of reputation.

Following Lee et al. (2011), we aggregate five measures of past VC investment action and performance, converted into *z*-scores to ensure proper scaling: (a) number of portfolio companies invested in the past 5 years, (b) amount invested in the past 5 years, (c) total funds raised in the past 5 years, (d) number of funds raised in the past 5 years, and (e) number of portfolio companies taken to IPO during the past 5 years. The resulting scores for all VC firms are updated annually, placing each VC firm relative to all others in a given year, consistent with the notion that reputation is "a continuous measure, placing each actor on a continuum from best to worst" (Deephouse & Suchman, 2008: 2). Because the *z*-scores take on negative values, we followed Lee et al.'s (2011) procedure to transform the aggregate reputation score on a 100-point scale. To each VC reputation value each year, we added a constant equal to 0.01 and the minimum reputation score for that year. We then divided each value by the highest reputation score observed in that year. This resulted in a positive reputation score that maintains ranking among the VC firms. Although Lee et al. (2011) also include VC firm age in the composite reputation index, we performed our analyses with age as a control variable to tease out the accumulated experience that may come with age. As a robustness check, we repeated the analyses with age as part of the reputation composite: All results remain consistent.

Sector legitimation. We created a composite index of the three sector legitimation factors identified by prior research—media attention, regulatory approval, and actions by peers—operationalized as follows: First, following prior research (Deeds et al., 2004; Pollock & Rindova, 2003; Pollock, Rindova, & Maggitti, 2008), we measure *media attention* to the clean energy sector in the year prior to the focal investment year. using the number of media articles that contain one of the following terms in the headline and lead paragraph: "clean energy," "green energy," "alternative energy," or a specific clean energy generation technology. The list of search terms was created based on the clean energy technologies listed on the Department of Energy website and the various Office of Energy Efficiency & Renewable Energy (EERE) glossaries (http://energy.gov/eere/renewables). We identified a total of 51,470 media articles published in U.S. journals, magazines, and newspapers as listed in the LexisNexis Academic database, growing from 367 in 1989 to 10,807 in 2007. Second, we measure the *regulatory approval* of the clean energy sector using the number of federal financial incentives for renewable energy and energy efficiency in a given year listed on DSIRE. Third, we measure *prior investments of peers* as the cumulative number of all VC firm investments in the clean energy sector up until the focal investment year. The correlations between the three variables are higher than 0.88, suggesting that they reflect the same underlying construct.[7] We standardized these variables prior to aggregating them into a single index. The value of the Cronbach's alpha is 0.97—well above the cutoff of 0.80 (DeVellis, 1991)—indicating high reliability of the legitimation index.

Control Variables

VC firm attributes. We control for VC firm status, experience, type, and location, because these attributes may influence VC investment decisions. Status and reputation are related, yet theoretically and empirically distinct constructs: Whereas reputation is based on "a past history of behaviors and performance," status is based on "an actor's position in a hierarchical social order" (Lee et al., 2011: 23; Rindova et al., 2006). It is important to tease out the potential effect of status, because it may influence VC firms' propensity to invest in an emerging sector through social network mechanisms rather than the hypothesized reputation

[7] We are grateful to an anonymous reviewer for suggesting the use of a composite index of sector legitimation.

effects. Following Hochberg, Ljungqvist, and Lu (2007) *and* Lee et al. (2011), we operationalize *VC firm status* as eigenvector centrality (Bonacich, 1987), reflecting each VC firm's direct co-investment connections in a given time period and weighting recursively each connection by the connected VC firms' centrality. For each year, we constructed adjacency matrices in which two VC firms had a direct tie if they co-invested over the 5-year window that ended in the year prior to the focal year.

Although firm reputation reflects demonstrated past success, which is based at least to some extent on learning and experience, the reputation construct does not necessarily capture the more general experience that firms accumulate over time and through various activities (March, 1991). To account for such experience that can influence VC investment decisions with regards to an emerging sector (Dimov, de Holan, & Milanov, 2012), we control for VC firm age, breadth of experience, and industry focus. *VC firm age* reflects the effect of tenure in the VC industry on a VC firm's disposition towards new sectors. We measure a *VC firm*'s *age* in years, from its founding to the focal observation year. Broader experience may influence a VC firm's propensity to invest in any new sector (Dimov & de Holan, 2010; Pollock, Fund, & Baker, 2009). Therefore we control for the *breadth of VC firm experience*, measured as the number of unique industry sectors (at the three-digit level of the Venture Economics Industry Codes in VentureXpert) in which the VC firm invested during the 5 years preceding the focal investment year. Our interviews with VC investors suggest that, in clean energy, the most relevant experience comes from prior investment in energy and energy-related startups, because firms with prior experience in "brown" energy may see clean energy as a natural next step, even though the technologies are fundamentally different. To control for *VC firm energy focus*, we constructed a dummy variable that takes the value of 1 if the focal VC firm has reported on VentureXpert that its industry focus is energy-related and of 0 otherwise.

We also control for *VC firm type*, because corporate VC investors make investments primarily for strategic reasons (Wadhwa & Kotha, 2006) and may have different motivations for making investments in clean energy than those of traditional VC firms. We include a dummy variable for *VC firm type* (as reported on VentureXpert), which equals 1 if the firm is a corporate VC and 0 otherwise. Finally, being located in California may bias VC firms positively towards the clean energy sector, because the state has been leading the "clean" movement in the United States for decades. Therefore we include a dummy variable *VC firm location* that equals 1 if the focal VC firm is headquartered in California and 0 otherwise.

Environmental factors. In addition to VC firm attributes, we control for the environmental factors not captured by the three sector legitimation variables: hotness of the VC market and past syndication with clean energy VCs. We control for the *hotness of the VC market* (Higgins & Gulati, 2003), measured as the total number of startups funded by all VC firms in the focal investment year, which reflects the propensity of VC firms to invest in any startup. We also control for the fact that some VCs may invest in the clean energy sector because they are connected to other VCs that invested earlier in this sector. The variable *past syndication with a clean energy VC* is measured as the number of "clean energy VC firms" with which the focal "at risk" VC firm co-invested in the 5 years prior to the focal year. This variable was log transformed to reduce skewness and kurtosis.

Estimation Methods

Estimating a VC firm's likelihood to invest. We follow research on firm entry in new technical fields, which uses discrete time logistic estimation methods (King & Tucci, 2002; Martin & Mitchell, 1998), to test the hypotheses related to the likelihood of a VC firm to invest in an emerging sector. The discrete time survival analysis estimation makes use of the property that the sample likelihood can be written in a form identical to the likelihood of a binary dependent variable multiple regression model and applied to a specifically organized dataset of firm-year observations (Allison, 1984), as in this study. Here, the dependent variable is a dichotomous variable reflecting the likelihood that a VC firm will make an investment in the clean energy sector. Because some of the independent and control variables change with time, the panel logistic specification (xtlogit function in STATA) allows us to update all time-varying variables annually. We use time dummies for each 4-year time period in the data and a random-effects specification to accommodate the control variables

that do not vary with time.[8] We lagged all independent and control variables by 1 year to ensure greater confidence in the causality of our hypothesized relationships. To ensure that our choice of estimation models did not drive our results, we also analyzed our data using a panel complementary log-log specification, which is recommended when the dependent variable does not have a high frequency of occurrence (Hosmer & Lemeshow, 1999).

Estimating the use of risk reduction strategies. Our second set of analyses involves three dependent variables, two of which are continuous variables (*use of syndication* and *use of later-stage investment*) and the third of which is a proportion (*level of commitment*), requiring different modeling approaches. We use panel linear regression models for predicting *use of syndication* and *use of later-stage investment*. To estimate *level of commitment*, which is a proportion and does not satisfy the assumptions of ordinary least squares (OLS) regression (Greene, 2003), we follow Papke and Wooldridge (1996) and estimate models using a panel generalized estimation equation (GEE) approach, specifying a probit link function and an exchangeable correlation matrix, and compute robust standard errors. We lagged all independent variables by 1 year and use time period dummies to control for systematic period effects.

Further, we use a variation of Heckman's (1979) two-stage approach to account for a potential sample selection bias (Hamilton & Nickerson, 2003) in that a VC firm's use of risk reduction strategies in an emerging sector is conditional upon its decision to invest in the sector. In the first stage, we run a probit model to estimate the likelihood that a VC firm invests in clean energy and to compute the inverse Mills ratio. The inverse Mills ratio is included in the second stage regression models, which estimate the effect of reputation, sector legitimation, and their interactions on the use of syndication, later-stage investment, and low levels of commitment. In the first stage probit model, we included the following variables that are likely to influence VC propensity to invest in the clean energy sector: the cumulative number of reputable VC firms that already invested in clean energy, past syndication with a clean energy VC firm, VC firm age, breadth of VC firm experience, VC firm industry focus, VC firm type, VC firm location, hotness of the VC market, and the time period dummy variables. The first two variables meet the criteria for "strong" instruments recommended by past research, assessed by the significance of the F-statistics and the non-significance of Sargan and Basmann tests (Bascle, 2008; Stock & Yogo, 2005).

[8] Note that using a fixed effects procedure is not appropriate for our sample, because it excludes variables that do not vary across observations in each firm panel. Because the majority (more than 95%) of VC firms in our sample did not invest in clean energy for the entire observation period, the dependent variable for all of their firm-years is zero. Fixed effects modeling would exclude all such VC firms from the analysis. Further, fixed effects estimation is not recommended for studies with a large number of firms and relatively short time panels, as in our sample (Greene, 2003).

RESULTS

Tables 1A and 1B present the descriptive statistics and pairwise correlation matrix of the variables in each panel. In Table 1A, the three VC-related variables—reputation, status, and breadth of experience—are highly correlated. Whereas this problem does not appear to be severe, based on variance inflation factor (VIF) and collinearity diagnostics (using the *coldiag* command in STATA), we performed additional analysis to ensure adequate discriminant validity of these variables. Following prior research (Pollock & Rindova, 2003; Sine et al., 2005), we orthogonalized these variables and repeated all analyses. All results remain consistent in direction and significance. We retain the original variables that allow for interpretation of the regression coefficients and for plotting the interaction effects.

Table 2 presents the results for the panel logistic regression used to examine the likelihood of investment in clean energy. Model 1 is the baseline model with only control variables. Models 2–4 introduce reputation, sector legitimation, and the interaction between them, respectively. As predicted by Hypothesis 1, we find that a VC firm's reputation has a positive and significant effect on its likelihood to invest in an emerging sector (Table 2, Models 2–4). Specifically, for one standard deviation increase in a VC firm's reputation, its odds of investing in clean energy increase by 1.25 times (Table 2, Model 2). We also find support for Hypothesis 3, which predicts a positive effect of sector legitimation on a VC firm's likelihood to invest in an emerging sector (Table 2, Models 3 and 4). For one standard deviation increase in the sector legitimation, a VC firm's odds of investing in the sector

TABLE 1A
Descriptive Statistics and Correlations: All Active VC Firm-Years (n = 37,293)

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Likelihood to invest	0.00	0.07	1.00										
(2) VC firm status	0.02	0.06	0.08	1.00									
(3) VC firm age	9.87	8.32	0.02	0.18	1.00								
(4) Breadth of VC firm experience	1.49	3.09	0.08	0.73	0.23	1.00							
(5) VC firm energy focus	0.01	0.10	0.03	−0.04	−0.03	−0.04	1.00						
(6) VC firm type = corporate	0.16	0.37	−0.01	−0.06	−0.01	−0.10	−0.02	1.00					
(7) VC firm location	0.25	0.43	0.02	0.13	−0.04	0.07	−0.04	0.04	1.00				
(8) Hotness of VC market	7759.85	3347.05	0.02	−0.07	0.01	0.02	0.01	0.01	0.02	1.00			
(9) Syndicated with clean energy VC in last 5 years	4.10	10.94	0.09	0.91	0.18	0.75	−0.04	−0.05	0.15	−0.02	1.00		
(10) VC firm reputation	2.62	5.53	0.10	0.82	0.16	0.72	−0.04	−0.12	0.11	−0.06	0.77	1.00	
(11) Sector legitimation	3.81	2.34	0.08	0.01	0.09	0.04	0.02	−0.03	0.03	0.41	0.02	−0.01	1.00

increase by 2.33 times (Table 2, Model 3). Hypothesis 5, predicting that the sector legitimation will strengthen the relationship between reputation and likelihood to invest in the sector, is also supported: The coefficient for the interaction between sector legitimation and reputation is positive and significant (Table 2, Model 4). The plot of this interaction shows that, at higher levels of sector legitimation, the slope of the line depicting the relationship between reputation and likelihood of investment becomes more positive (see Figure 1).

Table 3 shows the random effects panel linear regression results for use of syndication and later-stage investment. In support of Hypotheses 2a and 2b, VC firm reputation has positive and significant effects on the use of syndication (Table 3, Models 2 and 3) and later-stage investment (Table 3, Models 6 and 7), respectively. Sector legitimation has no significant effect on the use of syndication, failing to support Hypothesis 4a. Contrary to the prediction of Hypothesis 4b, sector legitimation has a positive and significant effect on the use of later-stage investment (Table 3, models 7 and 8). Both coefficients for the interaction effects of sector legitimation and reputation on the use of syndication and later-stage investment are positive and significant (Table 3, Models 4 and 8, respectively), contrary to the prediction of Hypotheses 6a and 6b. As Figure 2A shows, at higher levels of legitimation, the slope of the line depicting the relationship between reputation and use of syndication becomes more positive. Figure 2B shows a similar pattern for the slope of the line depicting the relationship between reputation and use of later-stage investment. Table 4 reports the GEE regression results for use of low levels of commitment (note that negative coefficients indicate greater use of this risk-reduction strategy). Reputation has a negative and significant effect on level of commitment, providing support for Hypothesis 2c (Table 4, Models 2–4). The effect of sector legitimation on level of commitment is

TABLE 1B
Descriptive Statistics and Correlations: Clean Energy VC Firm-Years (n = 709)

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Use of syndication	1.86	2.70	1.00										
(2) Use of later-stage investment	1.48	1.56	0.69	1.00									
(3) Level of commitment	0.13	0.24	0.32	0.52	1.00								
(4) VC firm age	13.82	8.41	0.02	0.02	−0.09	1.00							
(5) Breadth of VC firm experience	6.03	7.71	−0.01	0.05	−0.22	0.36	1.00						
(6) VC firm energy focus	0.03	0.16	0.02	0.08	0.19	−0.13	−0.11	1.00					
(7) VC firm type = corporate	0.09	0.29	0.03	−0.07	−0.04	−0.12	−0.14	−0.02	1.00				
(8) VC firm location	0.28	0.45	0.21	0.12	−0.01	−0.07	0.01	0.09	0.02	1.00			
(9) Hotness of VC market	8904.52	1924.08	0.10	−0.01	−0.05	0.14	−0.01	0.02	0.07	0.03	1.00		
(10) VC firm reputation	11.03	14.40	0.07	0.14	−0.22	0.34	0.75	−0.10	−0.15	0.12	−0.06	1.00	
(11) Sector legitimation	6.24	2.82	0.13	0.13	0.10	0.17	−0.02	0.16	0.00	0.14	0.25	0.03	1.00

TABLE 2
Logistic Regression (DV = Likelihood to Invest in the Emerging Sector)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	−4.28***	−5.17***	−5.78***	−8.90***
	[0.74]	[0.84]	[1.10]	[1.37]
VC firm status	0.55**	0.30^{+}	0.23	0.59*
	[0.17]	[0.18]	[0.19]	[0.30]
VC firm age	−0.16	−0.17	−0.19^{+}	−0.04
	[0.10]	[0.11]	[0.11]	[0.19]
Breadth of VC firm experience	6.00**	2.69	4.41^{+}	9.88*
	[1.89]	[2.19]	[2.47]	[4.10]
VC firm energy focus	2.57***	2.51***	2.62***	4.65***
	[0.36]	[0.38]	[0.47]	[0.94]
VC firm type = corporate	−0.59	−0.53	−0.50	−0.72
	[0.29]	[0.30]	[0.31]	[0.51]
VC firm location	0.18	0.12	0.13	0.21
	[0.17]	[0.18]	[0.19]	[0.34]
Hotness of VC market	0.21***	0.20***	0.01	0.03
	[0.05]	[0.05]	[0.08]	[0.08]
Syndicated with clean energy VC	0.07	0.11*	0.12*	0.16*
	[0.05]	[0.05]	[0.05]	[0.08]
VC firm reputation		0.04***	0.05***	0.04*
		[0.01]	[0.01]	[0.02]
Sector legitimation			2.93***	4.19***
			[0.64]	[0.76]
VC firm reputation × Sector legitimation				0.09**
				[0.03]
Observations	37,293	37,293	37,293	37,293
Number of VC firms	3,574	3,574	3,574	3,574
Degrees of freedom	13	14	15	16
Log likelihood	−926.30	−919.80	−906.80	−903.90
−2 Log likelihood		13.00	39.00	44.80
Chi Squared	314.10	204.70	117.90	127.80

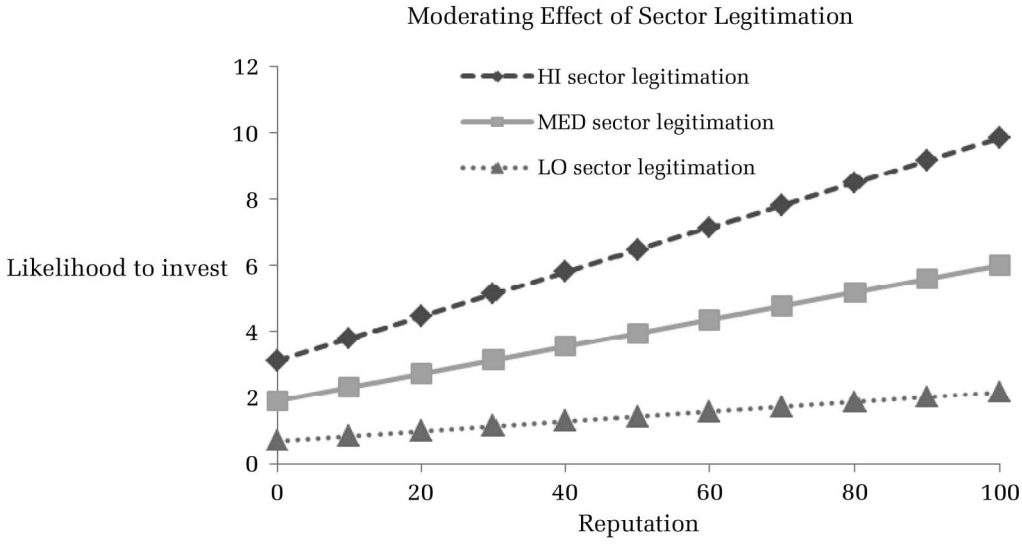
Note: Standard errors in brackets; one-tailed *z*-tests for variables of interest, two-tailed *z*-tests for all other variables.
$^{+}$ $p < .1$
* $p < .05$
** $p < .01$
*** $p < .001$

positive and significant (Table 4, Models 3 and 4), in support of Hypothesis 4c. The coefficient for the interaction effect of sector legitimation and reputation on level of commitment is not significant; thus Hypothesis 6c is not supported.

Supplementary Analyses

Firm reputation versus individual reputations. We use the VC reputation index developed by Lee et al. (2011), because it is the most advanced measure of VC firm reputation developed to date and the only one that captures both the prominence and quality dimensions of reputation. However, like other measures of reputation at the firm level of analysis, this index does not account for the individual reputations of the VC partners in a given firm. This may be a problem, because firms created during the period of this study would initially appear as having low reputation even if they were started by individuals with high personal reputations. For example, the seasoned VC investor Vinod Khosla left Kleiner Perkins to create Khosla Ventures. In our data, Khosla Ventures appears as having low reputation for its first few years of operation, yet one could argue that the individual reputation of Vinod Khosla endowed the VC firm with some reputation from its beginning (Fund, Pollock, Baker, & Wowak, 2008). To estimate the degree of this problem, we checked how many of the VC firms that invested in clean energy were started by individuals coming from highly reputable VC firms. We identified only two such cases—Khosla Ventures and Braemar Energy Ventures—

FIGURE 1
Effects of Sector Legitimation on the "Reputation–Likelihood to Invest" Relationship



and excluding them from the analyses did not change our results.

Firm reputation versus firm size. Another concern with using the VC reputation index is that the amalgamation of different components may hide the effect of VC firm size, which by itself may drive our results. To estimate this possibility, we followed Lee et al. (2011) and repeated all analysis, excluding the amount of funds under management, which is most likely to be associated with firm size. Controlling for funds under management, the remaining reputation composite still has positive and significant effects on all dependent variables. We repeated the same procedure for the number of startups previously invested in, because this component by itself may drive some of our results. Controlling for the number of startups previously invested in, the results for the remaining composite reputation index remain consistent with the original results. Thus we are confident that our results are not an artifact of VC firm size or number of startups in its portfolio.

Disaggregation of the legitimation index. Finally, to check if there are differences between the legitimation index and its three component variables, we repeated our analyses by entering each legitimation factor separately in the models instead of the composite legitimation index. All results remain the same in direction and significance, with the following exceptions. First, when using the legitimation index, the coefficient representing its relationship to syndication is positive, but does not reach significant level, whereas when rerunning the analysis with each of the three components separately, the coefficient for regulatory approval by itself reaches a significant level. Second, the effect of legitimation on later-stage investment is positive and significant when using the legitimation index, whereas, when using the three components separately, the coefficient for regulatory approval is not significant. These differences in level of significance may be the result of random error variance when using each component separately.

DISCUSSION

The main goal of this study was to articulate the dual pressures of a firm's reputation on its decisions and actions, and the extent to which they exert influence under conditions of ambiguity. We theorize that reputation raises a firm's aspirations for future performance, prompting it to act upon ambiguous business opportunities, but that it also increases the mindfulness of the potential negative consequences of such actions, leading to extensive use of risk reduction strategies. Our results show that reputable VC firms are more likely to invest in an emerging sector and that they tend to use risk reduction strategies more extensively. These findings highlight the significant and nuanced role that reputation plays in a firm's decision making. The second goal of this study was to examine the effects of the institutional environment on a firm's decision making under ambiguity. Consistent with our

TABLE 3
Random Effects Panel Linear Regression (DV = Use of Syndication and Later-Stage Investment)

Variables	DV = Use of Syndication				DV = Use of Later-Stage Investment			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	1.88	1.41	−0.57	−0.17	1.10	0.77	−2.07	−1.81
	[1.92]	[1.91]	[3.12]	[3.16]	[1.24]	[1.23]	[2.07]	[2.08]
VC firm age	0.06	0.01	−0.01	−0.01	−0.02	−0.06	−0.09	−0.09
	[0.14]	[0.14]	[0.14]	[0.14]	[0.09]	[0.09]	[0.09]	[0.09]
Breadth of VC firm experience	−2.65	−5.83	−3.70	−3.34	2.68	0.35	3.23	3.50
	[3.38]	[3.67]	[4.47]	[4.51]	[2.42]	[2.41]	[3.11]	[3.05]
VC firm energy focus	−0.42	−0.26	0.01	0.06	0.77	0.89	1.25*	1.28*
	[0.92]	[0.92]	[0.98]	[0.97]	[0.54]	[0.54]	[0.60]	[0.60]
VC firm type = corporate	0.10	0.11	0.04	0.02	−0.40^{+}	−0.39^{+}	−0.46*	−0.47*
	[0.41]	[0.40]	[0.43]	[0.43]	[0.22]	[0.21]	[0.22]	[0.23]
VC firm location	1.13***	1.04***	1.09***	1.09***	0.35*	0.29^{+}	0.38*	0.37*
	[0.28]	[0.29]	[0.29]	[0.29]	[0.18]	[0.18]	[0.18]	[0.18]
Hotness of VC market	0.08	0.09	0.10	0.09	−0.05	−0.05	−0.03	−0.04
	[0.07]	[0.07]	[0.07]	[0.07]	[0.05]	[0.05]	[0.05]	[0.05]
VC firm reputation		0.03**	0.03**	0.01		0.02**	0.02**	0.01
		[0.01]	[0.01]	[0.01]		[0.01]	[0.01]	[0.01]
Sector legitimation			1.12	0.70			1.74**	1.48*
			[1.38]	[1.40]			[0.73]	[0.76]
VC firm reputation × Sector legitimation				0.04*				0.03*
				[0.02]				[0.01]
Inverse Mills ratio	−0.38	−0.18	0.29	0.21	0.33	0.48	1.11^{+}	1.06^{+}
	[0.71]	[0.71]	[0.92]	[0.94]	[0.44]	[0.43]	[0.62]	[0.62]
Time dummies	Included	Included	Included	Included	Included	Included	Included	Included
Observations	709	709	709	709	709	709	709	709
Number of VC firms	172	172	172	172	172	172	172	172
Degrees of freedom	12	13	14	15	12	13	14	15
R-squared	0.07	0.08	0.08	0.08	0.04	0.06	0.07	0.07
Chi-squared	79.93	103.00	102.10	106.00	66.84	82.84	89.23	118.20

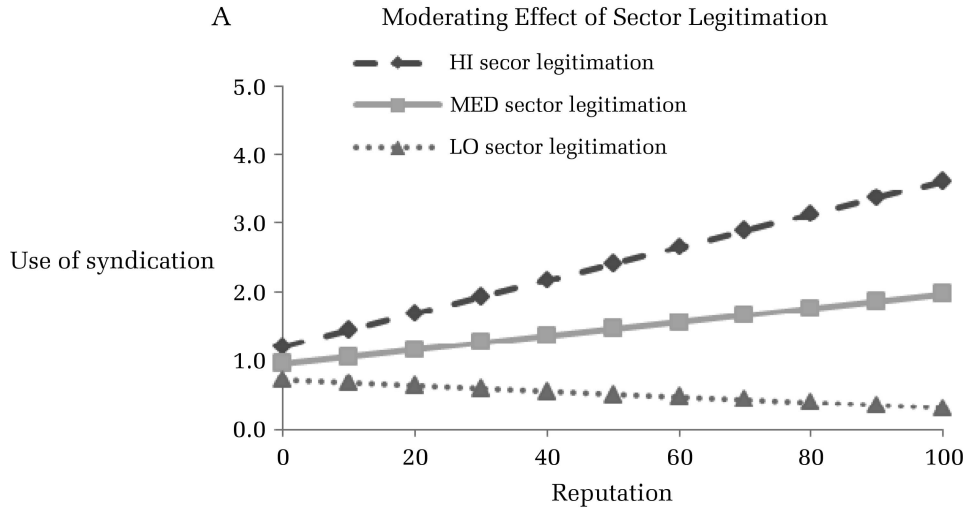
Note: Standard errors in brackets; one-tailed *z*-tests for variables of interest, two-tailed *z*-tests for all other variables.
$^{+}$ $p < .1$
* $p < .05$
** $p < .01$
*** $p < .001$

theorizing, we find that the legitimation of an emerging sector increases the likelihood of VC investment in it. However, it has different effects on the use of each risk reduction strategy and these differences deserve further research attention, as we discuss below.

Contributions to Theory and Practice

By examining the role of a firm's reputation in its decision making under ambiguity, our study moves beyond the self-reinforcing relationship between reputation and performance established in prior research (Fombrun & Shanley, 1990; Roberts & Dowling, 2002) to suggest that, under such conditions, a firm's reputation has more complex effects on its decision makers. Extant reputation research ignores the possibility for multiple conflicting interpretations typical under conditions of ambiguity (Garud & Van de Ven, 1992; March & Olsen, 1976), because it relies on the existence of shared understanding and agreement on the relevant dimensions of performance along which firms are compared as stakeholders form reputational perceptions about them (Lange et al., 2011; Rindova et al., 2005). Our focus on the role of reputation in decision making under ambiguity allows us to gain new understanding of the mechanisms through which reputation influences the interpretations of situations in which shared understanding is lacking. Whereas prior research portrays reputable firms as conservative in their decisions and actions (e.g., Pfarrer et al., 2010; Ippolito, 1992), our study shows that, under ambiguity, reputable firms are likely to ex-

FIGURE 2A
Effects of Sector Legitimation on the "Reputation–Use of Syndication" Relationship



periment with new and inherently risky strategies. Identifying such differences in the relationship between a firm's reputation and decision making in different contexts offers new insights into the ways in which reputation affects the strategies of the firms possessing it (Pfarrer et al., 2010: 1145).

Second, this study offers novel insights to reputation and legitimacy research by identifying the effects of sector legitimation on firms with different reputations. Prior research has established the relationships and differences between firm-level reputation and legitimacy (Deephouse & Carter, 2005; Deephouse & Suchman, 2008), as well as between firm reputation and the legitimation of the industry in which the firm is created (Rao, 1994). However, the legitimation of an emerging sector has been treated as an institutional context that uniformly affects all resource providers (Deeds et al., 2004; Sine et al., 2005; Sine et al., 2007). In contrast, our study shows that the growing legitimation of an emerging sector has a stronger impact on the investment strategies of reputable VC firms. These findings suggest that reputable firms are better positioned to identify changes in their institutional

FIGURE 2B
Effects of Sector Legitimation on the "Reputation–Use of Later-Stage Investment" Relationship

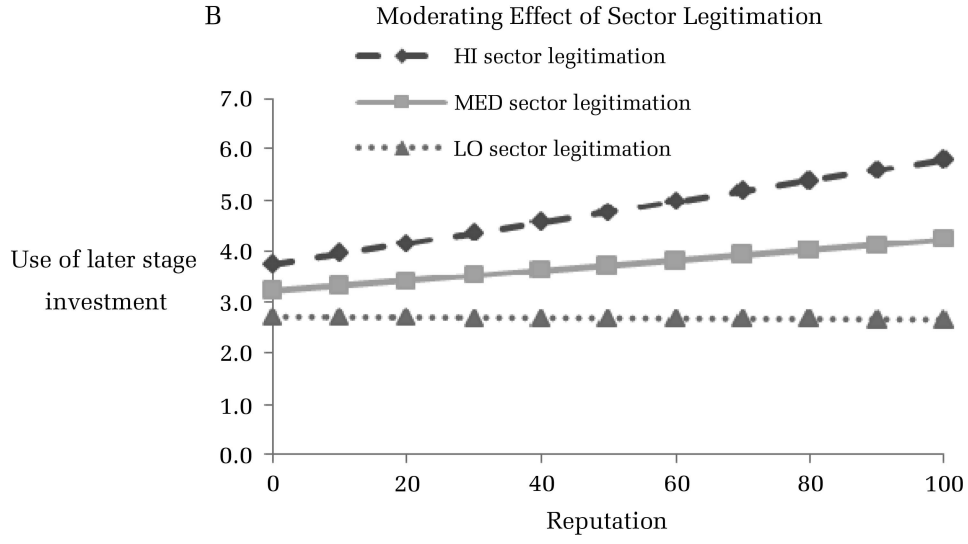


TABLE 4
GEE Regression (DV = Level of Commitment)

Variables	Model 1	Model 2	Model 3	Model 4
Constant	−2.71***	−2.54**	−6.58***	−6.50***
	[0.76]	[0.78]	[1.24]	[1.24]
VC firm age	−0.05	−0.03	−0.09	−0.09
	[0.07]	[0.07]	[0.07]	[0.07]
Breadth of VC firm experience	0.16	1.64	6.25***	6.19***
	[1.51]	[1.49]	[1.77]	[1.74]
VC firm energy focus	1.32***	1.25***	1.82***	1.82***
	[0.31]	[0.30]	[0.33]	[0.33]
VC firm type = corporate	−0.52**	−0.54**	−0.66***	−0.66***
	[0.18]	[0.17]	[0.19]	[0.19]
VC firm location	0.04	0.08	0.16	0.16
	[0.12]	[0.12]	[0.12]	[0.12]
Hotness of VC market	−0.08*	−0.08*	−0.06*	−0.06*
	[0.03]	[0.03]	[0.03]	[0.03]
VC firm reputation		−0.02*	−0.01*	−0.02*
		[0.01]	[0.01]	[0.01]
Sector legitimation			2.25***	2.18***
			[0.48]	[0.49]
VC firm reputation × Sector legitimation				0.01
				[0.01]
Inverse Mills ratio	1.04***	0.97***	1.94***	1.92***
	[0.27]	[0.28]	[0.38]	[0.38]
Time dummies	Included	Included	Included	Included
Observations	709	709	709	709
Number of VC firms	172	172	172	172
Degrees of freedom	12	13	14	15
Chi-squared	92.55	84.28	106.40	107.20

Note: Standard errors in brackets; one-tailed *z*-tests for explanatory variables, two-tailed *z*-tests for all other variables.
* $p < .05$
** $p < .01$
*** $p < .001$

environment and to act upon them strategically. Future research should examine if this capability translates into long-term performance benefits relative to less reputable peers.

Third, this study contributes to research on VC by examining important, yet often overlooked, socio-cognitive and institutional factors that affect VC firms' decisions in relation to their involvement with emerging sectors. The limited prior research on this topic identifies past experience (Dimov et al., 2012) and unusual individual foresight (von Burg & Kenney, 2000) as primary drivers of such involvement. Our study complements these perspectives by articulating the role of firm reputation and sector legitimation in VC decision making vis-à-vis emerging sectors. The strong focus on experience in prior research (e.g., Dimov & de Holan, 2010; Dimov & Milanov, 2010; Dimov et al., 2007) is well justified, given the highly specialized and often idiosyncratic knowledge and skills needed to perform VC activities. Consistent with this idea, in our data, both breadth of experience and energy industry focus positively influence a VC firm's likelihood to invest in the emerging sector (Table 2). However, neither experience nor energy focus predicts the use of syndication and later-stage investment strategies. These differences call for a more careful examination of the role of experience and reputation in VC decision making under ambiguity.

Further, although it is well known that VC firms use syndication, later-stage investment, and low levels of commitment to reduce uncertainty, we offer a new perspective on the relationship between a VC firm's reputation and the degree to which it utilizes these risk reduction strategies when investing under ambiguity. It is worth noting the differences in the relationships between reputation and use of risk reduction strategies in our study as compared to prior research on VC investment decisions under uncertainty. For example, Dimov et al. (2007) find that reputation reduces the tendency of VC firms with a finance background to invest in

later-stage startups, suggesting that reputable VC firms are less concerned with using later-stage investment as a risk reduction strategy. In a later study, Dimov and Milanov (2010) find a lower propensity among reputable VC firms to syndicate investments in less familiar sectors, suggesting the lower use of syndication as a risk reduction strategy on the part of these firms. In contrast, in this study, we find consistently positive relationships between reputation and the use of all three risk reduction strategies, which suggests that the more reputable a VC firm, the more carefully it manages the risks of investing under ambiguity. These differences support the theoretical and practical distinction between uncertainty and ambiguity when studying major organizational decisions (Garud & Van de Ven, 1992; Santos & Eisenhardt, 2009). Whereas knowledge and skills accumulated through prior experience may be useful for decision making under uncertainty, they are less relevant to decision making under ambiguity (Kahneman & Klein, 2009) because the lack of adequate understanding of the situation hinders decision makers' ability to utilize their experience (Starbuck & Milliken, 1988). Future research should further investigate the potential differences in the role of reputation and experience in firm decision making under conditions of uncertainty versus ambiguity.

Finally, the unexpected finding of our study—that sector legitimation impacts on the use of each risk reduction strategy differently—suggests that these strategies are neither equivalent nor mutually exclusive. Based on prior research, we expected that growing sector legitimation would reduce the use of all three risk reduction strategies. However, we found it only to reduce the use of low levels of commitment, but to increase the use of later-stage investment, and to have no significant effect on the use of syndication. One could speculate that, as sector legitimation grows, reputable VC firms invest in more clean energy startups to speed up their learning about the emerging sector—hence the higher levels of commitment that we observe—and that higher levels of commitment make these firms more exposed to potential failure, which in turn could explain their preference to invest in later-stage startups. The interaction effects that we observe are also surprising: Instead of attenuating the relationship between reputation and the use of risk reduction strategies, sector legitimation further magnifies the effects of reputation on the use of syndication and later-stage investment, and has no significant effect on its relationship to the level of commitment. Whereas these issues are beyond the scope of the current study, it is important that future research understands the theoretical and practical differences between these three risk reduction strategies, and accounts for the benefits and drawbacks of using each of them. Future research should also examine the rationale for using each strategy and the consequences of employing them in various combinations.

In addition to its theoretical contributions, this study highlights one factor contributing to the slow "emergence" of the clean energy sector that we have witnessed during the past decade. Because reputable firms have greater credibility when trying to convince others of the rationale behind their decisions and actions, they are better able to solicit the support of state, government, and other institutions (Lounsbury et al., 2003), and to legitimize new activities as acceptable, appropriate, and desirable (Haunschild & Miner, 1997; Rindova & Kotha, 2001). In the case of the clean energy sector, however, the support provided by reputable VC firms appears to be tempered by their extensive use of risk reduction strategies. Unlike other sectors in which small VC investments made enough difference to kickstart the sector (von Burg & Kenney, 2000), the huge capital requirements of clean energy (Ghosh & Nanda, 2010; Hargadon & Kenney, 2012) render such small-scale commitments inadequate. Therefore if policymakers and clean energy protagonists are to speed up the development of the sector, they may need to identify alternative sources of funding or find ways in which to encourage greater involvement among the VC community.

Limitations and Future Research Directions

One limitation of this study is the use of Lee et al.'s (2011) VC reputation index, which aggregates only firm-level data and does not account for the individual reputations accumulated by seasoned VCs. In our study, this would be a problem only if individual reputations and firm reputations were to be misaligned. We found only two such cases and excluding them from the analyses did not make a difference. However, it is conceivable that, in other contexts or when addressing different research questions, confounding individual- and firm-level reputations may be more problematic, especially when individual reputations are important for firm-level outcomes and may influence firm reputation substantively (Petkova, 2012). Examples of such contexts include business schools (Rindova et

al., 2005), professional service firms (Greenwood, Li, Prakash, & Deephouse, 2005), and startups founded by seasoned entrepreneurs (Petkova, Rindova, & Gupta, 2008). Therefore future research should account for possible confounding effects between individual and firm reputations.

Another limitation of this study that offers a fruitful avenue for future research stems from the syndication decisions of reputable VC firms when investing in an emerging sector for the first time. Reputable VC firms can invest alone or they can syndicate with other VC firms with different levels of reputation and experience. Although the syndication partner choices are beyond the scope of the current study (other than controlling for prior syndication with a clean energy VC investor), we examined the first-time clean energy investment of the 54 VC firms that ranked in the top 5% by reputation in their respective year. Of these firms: 30% invested alone; 35% syndicated alongside partners with lower reputations; and 35% syndicated with other reputable VC firms, most of which also had prior experience investing in clean energy. Given the overall small number of VC firms that invested in clean energy, it is premature to draw any conclusions from these observations. We encourage future research to examine in more detail the role of the sector-specific experience and reputation of prospective partners in VC firms' decisions to engage with an emerging sector.

Further, we limit our observation period to the end of 2008 because the incentives that the Obama administration created in 2009 resulted in a "gold rush" of subsidies to clean energy, which changed the dynamics of the sector (Lipton & Krauss, 2011) by triggering unprecedented levels of VC investment in it (Hargadon & Kenney, 2012). Whereas these events are beyond the scope of the current study, they offer unique opportunities for a "natural experiment" (Grant & Wall, 2009; Meyer, 1995) in which the sudden institutional change represents a shock in the environment for VC investment decisions. Given that some scholars question the suitability of the existing VC model for clean energy (e.g., Hargadon & Kenney, 2012), expanding the observation period beyond 2008 may also provide an opportunity to investigate whether the spur in VC investments triggered by the sudden increase in sector legitimation has led to the development of new investment models uniquely suited for this sector. Alternatively, it is conceivable that, despite all the government initiatives, the absence of other legitimizing events—such as successful exits via IPOs or acquisitions—may lead to slower legitimation of the emerging sector, which may in turn lead reputable VC firms to decelerate, or even abandon, their investments in this sector over time.

Finally, scholars should be mindful about the extent to which the theory developed in this study applies to other contexts. Whereas every firm should be concerned about its reputation (Fombrun, 1996), VC firms take risks quite often and may be able to tolerate ambiguity better than other decision makers. Also, the range of decisions that VC investors make is limited to investment-related aspects, while other decision makers may consider a wider repertoire of actions or risk reduction strategies. Further, reputational considerations may be particularly pronounced in knowledge-intensive organizations such as VC firms. Future research should examine the extent to which the theoretical mechanisms identified in this study apply to contexts that are less knowledge-intensive.

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