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Abstract

Technological discontinuities pose serious challenges to top managers' attention. These discontinuities, which often occur at the fringes of an industry, are usually driven by innovative and, often, venture capital-backed start-ups creating new products and transforming existing industries in ways that are difficult for incumbent managers to understand against the backdrop of their existing cognitive schemata. However, failing to appreciate and embrace successful technological discontinuities might endanger incumbents' very existence. Extending the attention-based view, we explore whether and how interorganizational relationships guide top managers' attention either to or away from technological discontinuities. We propose that homophilous relationships (e.g., alliances with industry peers) should exhibit a negative relationship with incumbents' timely attention to technological discontinuities, whereas heterophilous relationships (e.g., with venture capitalists as a result of co-investments) should exhibit a positive relationship. Furthermore, we hypothesize that the status of the partners strengthens the effect of homophilous and heterophilous relationships with the timely attention of top managers to technological discontinuities. Based on a longitudinal study of the incumbents in four information and communications technology industry sectors, we find that heterophilous ties through corporate venture capital (CVC) co-investing with high-status venture capital firms exhibit a strong positive relationship with timely attention. CVC, when it connects senior management to high-status venture capitalists (VCs) through co-investments, has a special role in directing top managers' attention to technological discontinuities and ensuing business opportunities. Implications for the understanding of the role of interorganizational ties as structural determinants of top managers' attention are discussed.

Keywords: attention, corporate venture capital, homophily, heterophily, status, technological discontinuity

Running title: Top Management's Attention to Discontinuities

Introduction

Recent research highlights the important role of managerial attention in developing effective organizational responses to technological discontinuities (Barr 1998; Barr et al. 1992; Eggers and Kaplan 2009; Kaplan 2008; Kaplan et al. 2003; Kaplan and Tripsas 2008; Tripsas and Gavetti 2000; Virany et al. 1992). This research suggests that a firm's response to technological discontinuities is shaped by how its senior managers pay attention to and interpret technological change (Daft and Weick 1984) and how they translate this cognition into effective strategic action (Bourgeois and Eisenhardt 1988). This research emphasizes that in times of discontinuous change, top management's attention allocation processes are central to shaping a firm's effective response to new technological paradigms (Barr et al. 1992; Eggers and Kaplan 2009; Kaplan 2008; Ocasio 1997).

Previous studies have provided ample evidence that senior management's attention is important, but prior research also suggests that addressing technological discontinuities poses important cognitive challenges to top managers' attention systems. Top managers usually focus their attention on information from familiar sources, such as their existing competition (Peteraf and Shanley 1997; Porac et al. 1995) or existing alliance partners. Given their time constraints, executives often interpret information using existing heuristics, cognitive frames, and knowledge categories based on past experience (Barr 1998; Barr and Huff 1997; Barr et al. 1992; Leonard-Barton 1992; Levinthal and March 1993). Although these information processing and sensemaking approaches are efficient in times of incremental change, when both the existing information sources and the information that they provide are reliable, they often fail in situations of discontinuous change. In these situations, knowledge pertaining to technological discontinuities is often fundamentally different from existing knowledge and does not fit neatly into existing cognitive frames (Kaplan and Tripsas 2008). Technological discontinuities are fundamental shifts from one dominant technology to another. These shifts frequently change the fabric of the industry, the rules of competition, and the identity of the industry's participants. These discontinuities often occur outside of an industry or at its fringes (Christensen 1997; Henderson and Clark 1990), creating new products and business models that are difficult to understand against the backdrop of existing business logic (Barnett and Pontikes 2008; Tripsas and Gavetti 2000). These new models typically involve a set of players that are not part of the networks in which incumbent firms

participate (Koka and Prescott 2008). However, failing to respond effectively to these discontinuities may endanger the very existence of an incumbent.

Prior research findings suggest that top management's attention allocation is a prerequisite to an effective organizational response to technological discontinuities. However, executives may fail to pay attention to these changes because of their information processing systems and cognitive frames. Thus, we are left with two related questions: What factors might support or hamper top management's attention allocation to technological discontinuities? How can organizations construct effective mechanisms to guide top managers' attention to technological discontinuities?

In this paper, we extend the attention-based view of the firm (Hoffman and Ocasio 2001; Ocasio 1997, 2011; Ocasio and Joseph 2005) to theorize on the structural determinants of top management's attention. In particular, we focus on the external mechanisms that firms employ to direct their top management's attention to technological discontinuities. We propose that various types of interorganizational relationships have differing effects on top management's attention and, in particular, that homophilous relationships with industry peers may negatively affect timely attention to emerging technological discontinuities, whereas heterophilous relationships (e.g., relationships with prominent VCs) may guide top management's attention toward emerging discontinuities. In line with the principle of the structural distribution of attention (Ocasio 1997), interorganizational relationships allow corporations to create a strategic context in which top managers are exposed to technological discontinuities. We further argue that the effects of these external mechanisms are strengthened by the status of the relationship partner.

We test our arguments on the role of homophilous and heterophilous interorganizational ties and the role of partners' status in these ties in shaping management's attention to technological discontinuities using a sample of the largest US corporations from four information and communication technology industry sectors between 1989 and 2000. Incumbents in these industries faced two technological discontinuities, the Internet and wireless, that profoundly altered their industry definition and the rules of competitive rivalry. The emergence of the Internet and wireless technologies (e.g., mobile telephony and wireless local area networks (WLANs)) also spawned a large number of new business opportunities and subfields that required substantially different skills and competencies than those that incumbents typically had, sometimes blinding them to the potential gains from competing in this arena. Constructing full alliance and VC syndication networks to examine the effects of homophilous and heterophilous

interorganizational ties and partner status in these two different networks, we found support for a strong positive effect of partner status in heterophilous ties. Homophilous ties through alliances with industry peers do not have a clear negative effect as predicted, but the effect of these relationships appears to depend partially on partners' attention to discontinuous opportunities.

Our study extends the attention-based view from an examination of the structural determinants within the organization to include also interorganizational relationships. Our results suggest that corporations can direct top management's attention to technological discontinuities by creating an appropriate external structural context for a firm. We view interorganizational relationships as a mechanism through which incumbents expose their top management to important issues in the operating environment, enabling them to overcome potential blind spots in their attention allocation system.

We also contribute to research on technological discontinuities and change. Recent research has begun to develop a cognitive perspective on technological change and firms' responses to this change (Kaplan and Tripsas 2008; Tripsas and Gavetti 2000). Our findings extend prior research that has emphasized the importance of attention to discontinuities by highlighting the need for a deeper understanding of the circumstances under which top managers pay attention to such discontinuities.

Our study also adds to the social network literature. There is a long-standing debate on which network structures provide the most benefits to firms (Burt 1992; Coleman 1988; Lee 2007), but researchers have only recently begun to explore the importance of network composition in explaining a firm's gains as a result of the multitude of networks to which it is connected (Lee 2008). We contribute to this literature by distinguishing between relationships with homophilous and heterophilous partners and by showing the differing effects of these relationships on top management's attention. In addition, we hypothesize and test differing effects of partner status in homophilous and heterophilous interorganizational relationships. Although the high status of partners in heterophilous ties exhibits a positive effect on top management's timely attention to discontinuities, the status of partners in homophilous ties seems to have a different effect.

The results contribute to the emerging literature on CVC, especially its role in corporate innovation activities. In CVC investments, large corporations invest in start-ups alongside traditional VC firms (Gompers and Lerner 1998). These investments are usually made with the intent of gaining strategic benefits (e.g., learning about emerging new

technologies or business models) as well as financial benefits (Dushnitsky and Lenox 2005a; Dushnitsky and Lenox 2005b; Wadhwa and Kotha 2006). CVC investments have frequently been viewed as a window on technology or a technology radar (Dushnitsky and Lenox 2006; Keil et al. 2008a; Siegel et al. 1988) that helps to enhance the recognition of emerging technologies and related business models among CVC managers and senior executives. Prior studies have shown that CVC investments are related to increased innovation rates when measured through patenting rates (Dushnitsky and Lenox 2005b; Schildt et al. 2005; Wadhwa and Kotha 2006). More recently, research has highlighted the limits of direct knowledge flows from ventures to the corporate parent (Dushnitsky and Shaver 2009). Recent studies have also begun to compare learning from CVC investments and other forms of interorganizational relationships (Dushnitsky and Lavie 2010; Keil et al. 2008b). We add to this stream of research by emphasizing that the contribution of CVC activities to corporate innovation might be less crucial in transferring patentable knowledge to the corporate parent than in directing top management's attention to important technological changes in the firm's external environment.

Technological Discontinuities and Firm Attention

Incumbents and Technological Discontinuities

Technological change is often an incremental but cumulative process that is punctuated by short revolutionary periods in the form of discontinuities (Tushman and Anderson 1986). Some of these discontinuities represent major technological shifts that are so significant that no change in scale, efficiency, or design can keep existing technologies competitive (Anderson and Tushman 1990; Tushman and Anderson 1986). Faced with such discontinuities, some incumbents fail to adapt effectively to these changes, leading to erosion of their market positions (Henderson 1993; Henderson and Clark 1990; Hill and Rothaermel 2003; Rosenbloom and Christensen 1994; Tushman and Anderson 1986).

There is agreement that incumbents encounter serious difficulties in adapting to technological discontinuities, but the reasons behind these difficulties remain a subject of debate. These reasons may include the different economic incentives of new entrants and incumbents in pursuing discontinuous innovation (Christensen 1997); forces of inertia, such as organizational identity (Tripsas 2009), path dependency, escalation of commitment, and irreversible commitments (Henderson and Clark 1990; Tushman and Anderson 1986); existing organizational

routines and capabilities that lead to suboptimal responses to radical shifts (Levinthal and March 1993; Nelson and Winter 1982); cognitive barriers in noticing or interpreting new technologies (Danneels 2011; Gilbert 2005; Leonard-Barton 1992); and the embeddedness of incumbents within established industry networks that do not initially value the new technology (Rosenbloom and Christensen 1994).

Recent explanations of incumbents' difficulties in recognizing and responding to technological discontinuities underscore senior management's attention as a key explanatory variable (Barr 1998; Cho and Hambrick 2006; Kaplan 2008; Kaplan et al. 2003; Kaplan and Tripsas 2008; Ocasio 1997). For instance, in a series of studies, Kaplan and her colleagues (Eggers and Kaplan 2009; Kaplan 2008; Kaplan et al. 2003) found that incumbents whose CEOs or top management teams paid timely attention to emerging technological discontinuities were more likely to invest in new technology and to produce effective responses to emerging competitive threats. Although these studies establish a clear link between senior managers' attention to discontinuities and their effective firm response, they leave a question unanswered: Why do senior managers in some incumbent firms pay attention to these discontinuities, whereas others do not? In other words, what are the factors that influence senior managers' attention allocation to emerging technological discontinuities? Insights into these issues can be gained by applying the attention-based view of the firm, developed by Ocasio (1997) and discussed in the next section.

Managerial Attention to Discontinuities

Drawing on the Carnegie School, particularly the work of Herbert Simon (1947), Ocasio (1997) suggests that the structuring of attention in organizations is one of the central explanations of firms' behavior. Organizational attention is defined as "the distinct focus of time and effort by the firm on a particular set of issues, problems, opportunities, and threats and on a particular set of skills, routines, programs, projects, and procedures" (Ocasio, 1997, p. 188). From this perspective, organizations function as systems of procedural and communicational channels that receive issues and possible responses to these issues from the environment and feed this information to decision makers for processing (Ocasio 1997; Vissa et al. 2010). The decision outcomes are therefore not determined solely by the characteristics of the decision makers but are shaped by the specific organizational context and the situations of individual decision makers (Ocasio 1997, p. 189). Ocasio (1997) identifies three principles that underlie the attention-based view: managerial action is usually focused on the issues to which managers pay attention; attention is situated,

meaning that the context in which decision makers are embedded affects their attention and the outcomes of their decisions; and attention is structurally distributed; that is, the context in which decision makers find themselves depends on how organizations structurally distribute and control the allocation of issues, answers, and decision makers.

To understand why senior managers may pay attention to technological discontinuities, it is particularly important to understand the structural determinants of attention. Ocasio (1997) proposes that the rules of the game, resources, players, and social positions within a firm combine to determine the legitimacy, importance, and relevance of issues and possible organizational responses to these issues. The rules of the game usually reflect the formal and informal principles of action, interaction and interpretation upon which decision makers draw in accomplishing their tasks (Ocasio, 1997). In the face of technological discontinuities, existing rules of the game can become counterproductive because they may filter information about a given discontinuity, thereby limiting top management's attention to that discontinuity (Leonard-Barton 1992; Levinthal and March 1993). Similarly, existing resources may bias the attention of decision makers toward response repertoires that build upon these existing resources (Leonard-Barton 1992; Levinthal and March 1993).

In addition to the rules of the game and resources, the role of players and structural positions as structural determinants of attention allocation are important in understanding firms' responses to discontinuities. Players refer to individuals and groups within or outside an organization that influence decision makers. To date, research on the role of different players has focused largely on the CEO and other top management team members and their role in shaping organizational attention (Cho and Hambrick 2006; Eggers and Kaplan 2009; Hambrick and Mason 1984; Kaplan 2008; Kaplan et al. 2003; Yadav et al. 2007) and firms' responses to emerging issues. For instance, Cho and Hambrick (2006) show that top management teams' demographics influence firms' attention to industry deregulation and that this change in attention allocation leads to changes in company strategy. Similarly, Yadav et al. (2007) show that the future orientation of a firm's CEO is a predictor of that firm's speed in responding to technological change.

Closely related to the concept of players is the structural position of decision makers and other players in the corporation. The distribution of structural positions shapes attention patterns by providing decision makers and other players with interests, values, and identities that guide their attention to different aspects of the organization's environment (Ocasio, 1997). For instance, in the context of attention to subsidiary issues, Bouquet and Birkinshaw

(2008) find that the structural position of a subsidiary within the network of subsidiaries, measured through the attractiveness of its market and its strengths compared to other subsidiaries, is an important predictor of the attention a subsidiary receives from the parent multinational corporation.

Taken together, previous studies have greatly enriched our understanding of how the characteristics of players, such as the composition of the top management team or the CEO's future orientation, influence their attention allocation patterns. Yet, the focus of these prior studies has been on players and structural positions that exist within the boundaries of the firm. However, attention patterns in organizations are also influenced by players outside the firm's boundaries (Ocasio, 1997). The influence of these players on attention patterns has received relatively little recognition in the literature. Furthermore, structural positions, such as status, may shape attention patterns and guide decision makers' attention to different aspects of the environment (Ocasio 1997). In the following sections, we will develop hypotheses about how players external to a firm influence attention allocation patterns within the firm, and we will empirically test these hypotheses. In particular, we will focus on the effects of heterophilous versus homophilous interorganizational partners (types of players) and their status (structural position) as structural antecedents of top management's attention to technological discontinuities.

Interorganizational Relationships and Managerial Attention

Interorganizational relationships constitute an important communication channel through which organizations and their decision makers interact with different players in a firm's external environment. Social network literature points out that through these interorganizational relationships, firms receive important information about events in their external environment and their potential implications for the firm (e.g., Koka and Prescott 2008; Lee 2007). Interorganizational relationships can help to reduce a firm's uncertainty about the nature of business opportunities by giving the firm's decision makers access to different external information sources (Burt 1992; Granovetter 1973).

We expect interorganizational relationships to play a particularly important role in guiding attention related to technological discontinuities. As noted, these discontinuities often emerge at the fringes of an industry, outside the normal focus of attention of incumbents' senior decision makers (e.g., Tripsas 1997). These discontinuities often draw upon radically new knowledge or require operating and organizing principles that are not easily comprehended within industries' existing cognitive frameworks. The fact that these discontinuities involve a high degree of market and

technological uncertainty makes the evaluation of their likely impact on incumbents' businesses exceedingly challenging. The uncertainty that surrounds these discontinuities may even lead some decision makers to ignore them. Interorganizational relationships can reduce the perceived uncertainty (Lee 2007) of these discontinuities, drawing attention to them and even shaping senior executives' attention to these discontinuities. In situations of high uncertainty, decision makers' perceptions of the quality of information received through interorganizational relationships is often shaped by the status of the source.

However, research also suggests that network benefits do not occur under all circumstances. Interorganizational networks may even become a liability when the nature of these networks is not aligned with the information needs of the focal firm (Gargiulo and Benassi 2000; Koka and Prescott 2008). For instance, research on social networks suggests that individuals and organizations exhibit a tendency toward homophily (Luo and Deng 2009; McPherson et al. 2001), defined as the tendency to associate with similar others and to trust their advice (McDonald et al. 2008). Such homophilous network contacts may hold similar views (McDonald et al. 2008), and they may not possess sufficiently dissimilar information to help steer attention allocation patterns away from routine processing in light of high uncertainty, or they may even have incentives to direct attention away from emerging discontinuities. In the next section, we develop hypotheses for different types of interorganizational relationships and their potential impact on the timely attention to discontinuous business opportunities in incumbent firms.

Homophilous Relationships with Industry Peers and Top Management's Attention to Discontinuities

One set of inter-organizational relationships that may shape the attention allocation of incumbents' top managers are links that these firms establish with other incumbent firms in the same industry. Incumbents frequently form close alliances with other incumbents to extend supplier relationships and customer relationships or to create horizontal cooperation. In their alliances with industry peers, incumbents cooperate on a broad set of issues that include early stage research, technology standardization, and manufacturing as well as joint go-to-market strategies or joint marketing. Although these relationships have diverse purposes, they are characterized by intense business development activities and frequent information exchange (Dyer and Singh 1998). For instance, in an R&D alliance, firms may jointly develop new technology and, in the process, exchange detailed information about technological trends. Furthermore, in alliances with customers or suppliers, information about technological developments is

frequently exchanged to align roadmaps (Heide and Miner 1992). Even in less technology-oriented relationships, such as manufacturing or marketing relationships, partners may exchange information about market trends that influence joint understanding of technological shifts (Hagedoorn 1993).

Alliance relationships with industry peers are characterized by a high level of homophily because firms in the same industry frequently share a large number of similarities in their organizational forms, knowledge, experiences and mental frameworks (Porac et al. 1989; Porac et al. 1995; Prahalad and Bettis 1986). Even within an industry, firms frequently form links with relatively similar partners (Luo and Deng 2009). Similarity among alliance partners may make it easy to absorb information from a partner (Lane and Lubatkin 1998) and may provide organizational decision makers with psychological comfort when assessing information from these familiar sources (McDonald et al. 2008), but homophilous relationships may also direct top management's attention away from technological discontinuities for several reasons.

First, industry peers and the focal firm may have relatively similar knowledge and information. Given that discontinuous technological change often arises outside of the industry or, at least, at its fringes (Christensen 1997; Henderson and Clark 1990) and frequently builds on knowledge that is new to the industry (Kaplan and Tripsas 2008), peer incumbents are less likely to be good sources of knowledge and information about emerging technological discontinuities.

Second, because firms in the same industry often show striking similarities in their definitions of competitors, operating principles, and technologies (Bettis and Prahalad 1995; Porac et al. 1989; Porac et al. 1995), a peer incumbent's views on emerging discontinuities are likely to resemble those held inside the focal firm and are therefore unlikely to guide incumbent decision makers' attention toward technological discontinuities; instead, inertial forces within the incumbent firm may be cemented. In line with this reasoning, Koka and Prescott (2008) argue that dramatic changes in the environment often modify the existing bases of competition, and firms that are centrally positioned in existing industry networks are likely to be adversely affected by this shift because the information they gain from their existing ties may lose relevance after a change.

Third, even if incumbents have information about discontinuities and recognize the value of this information, they may not have an incentive to share this information with a within-industry peer. Incumbents' alliance partners are likely to have a considerable stake in existing technologies and may be equally threatened by a discontinuity. Thus,

they may use these alliance relationships to influence peers against adopting a technological solution that could threaten both the focal firm and its partner.

Finally, the nature of the relationship with peer incumbents may bias management's attention to routine business development issues. Managing ongoing alliance relationships often requires substantial time and managerial attention. Thus, most of these relationships are dominated by routine business development issues that will be relatively comfortable for managers in the focal firm given the similarity of the alliance partner. Thus, alliances with peers may further direct and even bias top management's attention to relatively routine business development issues rather than promoting mindful interpretation of weak signals that are related to emerging technological discontinuities (Salvato 2009). Thus, we hypothesize as follows:

HYPOTHESIS 1: The larger the number of homophilous interorganizational ties to industry peers, the later the time at which top management will pay attention to emerging discontinuous technological change.

Status, Homophily, and Top Management's Attention to Discontinuities

We expect the negative relationship of homophilous relationships to industry peers and the timely attention of top management to technological discontinuities to be further strengthened if these relationships are developed with high-status partners (Podolny 2005). The status of a player in an industry can be defined as the position it occupies in the social hierarchy (Podolny 2005). Contrary to a firm's reputation, which directly reflects past behavior (Fombrun and Shanley 1990), status is a reflection of the patterns of relations and affiliations in which a firm is engaged. High-status firms are incumbents that have developed a central position in the social network of an industry over time. We expect status to strengthen the effects of homophily through two interrelated mechanisms.

First, given how status accrues over time, high-status industry peers are less likely to be engaged in or hold information about technological discontinuities compared with lower-status industry peers. Firms gain status by being selective in their interactions with others and by focusing on relationships with other high-status firms in an industry at the expense of relationships with more peripheral firms (Podolny 1993). As we have argued, technological discontinuities often emerge at the fringes or outside of an industry and are frequently created by completely new firms that have no status in the industry. Therefore, the strategies used by high-status firms to maintain their status may limit their ability to interact with firms that pursue technological discontinuities. Given that high-status industry

peers are less likely to be involved in inducing technological discontinuities, these firms will likely influence top managers' attention patterns toward the incremental developments of existing technologies.

High-status firms are not only less likely to engage in and hold information on technological discontinuities, but the focal firm's top management will also attach a particularly high weight to information from high-status incumbent peers. In assessing information from different external sources, top managers must simultaneously evaluate both the information and the quality of the source of information. Research on social networks suggests that in such situations, the status of the actor is frequently used as a signal for the quality of the actor and, by extension, for the quality of their information (Podolny 1993, 1994; Podolny 2001). Because managers face a high level of uncertainty about the ability of a partner to provide high quality information about emerging discontinuity, they revert to the general assessment of that partner by industry peers that is reflected in its industry status. For instance, members of the top management team are more likely to give greater weight to information from IBM, Microsoft, or Hewlett Packard – all high-status firms in the industries we studied – than from a marginal firm or a newcomer to the industry.

In light of emerging technological discontinuities, high-status firms may utilize the weight that others (peers) attach to their knowledge and information to shape technological trends in their favor by actively influencing attention patterns among suppliers, customers, and horizontal alliance partners. For instance, in the early 2000s, incumbent telecommunications infrastructure companies were highly invested in cellular technology for wireless data transmission. When several alternative wireless data technologies were proposed by relative newcomers to the industry, one of the responses by high-status incumbents was to downplay the importance of these technologies in their official communications.

Taken together, the above observations lead us to propose that high-status industry peers may be less likely to hold information on technological discontinuities and may have a particularly strong influence in drawing focal firm's attention toward incremental technological developments. Therefore, we hypothesize as follows:

HYPOTHESIS 2: The higher a partner's status in homophilous interorganizational ties, the later the time at which top management will pay attention to emerging discontinuous technological change.

Heterophilous Interorganizational Relationships with VCs and Attention to Discontinuities

Although homophilous interorganizational relationships with industry peers may be a source of inertia in managers' attention allocation to technological discontinuities, we expect that relationships with firms that exhibit heterogeneity from an incumbent would facilitate top management's attention to discontinuities. By forming heterophilous interorganizational relationships, an incumbent may be able to gain access to more diverse information and diverging viewpoints that can help to reshape attention patterns within the incumbent. Some heterophilous relationships may further create external structures that are particularly geared to focusing top management's attention on non-routine events and thus improving attention quality (Rerup 2009; Salvato 2009).

Our study focuses on one specific set of relationships that incumbents form by co-investing with VCs when making CVC investments (Dushnitsky and Lenox 2005a) in start-ups. In CVC investments, large corporations invest in start-ups alongside traditional VC firms (Gompers and Lerner 1998), usually aiming to gain both financial and strategic benefits, such as knowledge about emerging technologies or business models (Dushnitsky and Lenox 2005a; Dushnitsky and Lenox 2005b; Wadhwa and Kotha 2006). CVC investments directly connect the incumbent to start-ups that focus on exploiting a technological discontinuity. Start-ups are likely to have very different knowledge and may use very different cognitive frameworks to evaluate emerging technological discontinuity than focal incumbents. For instance, by interacting regularly with start-ups through board memberships, incumbent managers may develop a deeper understanding of emerging discontinuity.

CVC investments also connect the incumbent to other VCs that invest in these ventures because most incumbents co-invest alongside multiple VCs in so-called syndicated investments. Syndication enables VCs to share risks (Wilson 1968) and exchange information about a start-up's management and technologies (Lerner 1994). By investing in syndicates with traditional VCs, incumbents gain access to a community of investors that specialize in assessing nascent technologies and spotting emerging discontinuities. Given that VCs frequently share information about the ventures they consider during syndication, access to VCs provides high quality information about new ventures and discontinuous technologies they may pursue. Access to the VC community may be valuable beyond the individual venture being considered because senior managers may gain the opportunity to regularly exchange information with VCs about the broader evolution of technologies and emerging business subfields. In addition to holding different information and possessing different cognitive frameworks to evaluate technological discontinuities,

VCs are more likely to draw management's attention to emerging discontinuities than their peer incumbents are. VCs have no (or, at least, less) vested interest in existing technologies. Instead, they may have incentives to actively support emerging discontinuities to support the businesses in which they invest. Therefore, VCs may share information about and draw incumbent managers' attention to potential technological discontinuities.

Creating a mechanism to regularly focus on identifying potential discontinuities is important for the quality of attention to discontinuities. Firms usually face a tradeoff between strong attentional engagement (Ocasio 2011) to few issues (by focusing their cognitive resources on a selected set of stimuli over a period of time and thus improving the quality of their attention to these stimuli (Rerup 2009; Weick and Sutcliffe 2006)) and emphasizing the deliberate management of non-routine events through mindful exploration of a larger number of issues by the top management team (Ocasio 2011; Salvato 2009). Given the prevalence and short-term pressures of ongoing business development, top management teams may emphasize a smaller number of issues, and ongoing routine business development may crowd out the exploration of emerging discontinuities. Given that discussions with VCs typically focus on non-routine events and are largely free of the short-term pressures of routine business development, frequent interactions between VCs and top managers may create a mechanism that routinizes the mindful exploration of weak signals and allow incumbents to overcome the trade-off between routine and mindful behavior (Levinthal and Rerup 2006; Salvato 2009). This mechanism can expedite incumbents' recognition of technological discontinuities. Therefore, we hypothesize as follows:

HYPOTHESIS 3: The larger the number of heterophilous interorganizational ties with VCs, the earlier top management will pay attention to emerging discontinuous technological change.

Bridging to Networks of High-Status VCs: Status, Heterophily and Attention to Discontinuities

Heterophilous interorganizational relationships created through CVC investments connect incumbents to emerging communities of firms that focus on commercializing technological discontinuities, particularly the VC investors who finance these new firms. In this way, incumbent managers may regularly be exposed to diverse types of information and divergent views about emerging technological discontinuities. However, to ensure a lasting impact on top management's attention patterns, it is important that the information about the technological discontinuity and its source is credible. In heterophilous relationships, incumbent managers usually interact with highly dissimilar

partners, which may make it difficult to assess the trustworthiness of information received from these sources (Luo and Deng 2009; McDonald et al. 2008; McPherson et al. 2001). For instance, top managers are unlikely to be easily convinced by the statements of a start-up manager or an unknown VC investor. In heterophilous relationships, there is a risk that such information is available but managers may opt to ignore it because of uncertainty about the quality of information and the credibility of its source. The social network literature (Podolny 2005) suggests that in heterophilous relationships, the status of the partner plays a critical role in alleviating this uncertainty and in strengthening the effect of heterophilous ties.

In particular, for CVC investments co-invested with VCs, we expect that the status of the other VC investors with whom an incumbent co-invests is critical in guiding top management's attention to emerging technological discontinuities. The new ventures in which an incumbent invests typically have a very limited track record, making it difficult to form status differentials. However, VCs who co-invest with the incumbent are widely considered experts on emerging technological discontinuities and start-ups and usually have well-established track records on which to form status assessments. In fact, the VC industry is one of the most frequently cited examples of environments where large status differences exist between VC companies, such as Kleiner Perkins Caulfield & Byers, Sequoia Capital, and Draper Fisher Jurvetson, and more peripheral investors (Podolny and Castelluci 1999). Confronted with uncertainty, incumbent firms' senior managers are likely to revert to the status of the VC firm when evaluating the information received from VC sources. Thus, information obtained from a high-status VC company is more likely to influence senior management's judgments on the importance of a technological discontinuity than information from less centrally placed players.

Contrary to peer incumbent networks, in which we expected centrally positioned high-status peers to have less information about emerging discontinuities, we expect the opposite in VC networks. VC firms are deeply involved in commercializing technological discontinuities because these discontinuities have high value-creation potential (von Burg and Kenney 2000). The literature on VC syndication also suggests that these centrally positioned VCs usually possess information advantages over VCs that are more peripherally positioned (e.g., Freeman 1999; Hochberg et al. 2007; Hochberg et al. 2010; Sorenson and Stuart 2001). Knowledge about the quality of the start-up firms in which VCs invest is scarce. To gain confidence in the quality of a start-up and the technology it seeks to commercialize, VCs must probe and crosscheck several sources of information about these technologies and their developers. This

due diligence process becomes extremely difficult when the VC holds a peripheral position in the network. In contrast, VCs that are centrally located in a network can tap into the knowledge of multiple partners, compare their information and make reasonable inferences about the quality of the technology and its future trajectory (Greve 2009; Powell et al. 1996). To protect their status and trade secrets, centrally positioned VCs typically syndicate predominantly with other centrally positioned VCs (Hochberg et al. 2007) or with corporate investors that possess complementary resources that compensate for their lack of status in the VC community (Keil et al. 2010). As a result of this network dynamic, high status VCs may not only have more influence on top management's attention allocation but may also give managers superior information about the likely impact of emerging technological discontinuities. Therefore, we hypothesize as follows:

HYPOTHESIS 4: The higher the status of the partners in heterophilous interorganizational ties, the earlier top management will pay attention to emerging discontinuous technological change.

Methods

Empirical Setting

To test our hypotheses on the role of different types of interorganizational ties as structural antecedents of top management's attention to emerging technological discontinuities, we collected longitudinal data from the largest companies (US-based companies that are publicly traded in US stock exchanges with revenues above 200 million US dollars in 1989) in four ICT industries covering the three-digit standard industrial classification (SIC) codes 357 (computer and office equipment), 366 (communications equipment), 367 (electronic components and accessories), and 737 (computer programming, data processing and other computer-related services) for the period of 1989-2000. To prevent survivor bias, we applied the selection criteria at the beginning of the sample period and followed the companies to the end of the sample period or until they were acquired or ceased operations. This created an unbalanced panel data set.

We focused on the 1989 to 2000 period, which witnessed the rise of the Internet and wireless technologies (Mowery and Simcoe 2002; Szulanski et al. 2004). At the beginning of the sample period (the beginning of the 1990s), the Internet as a business phenomenon was still unheard of, and wireless technologies were in their infancy. However, new start-ups began to explore the field in the early 1990s. Around 1994, some leading VCs, such as

Kleiner Perkins Caufield & Byers, began actively investing in the Internet by funding revolutionary start-up companies such as Netscape and Amazon.com. Wireless technologies, such as WLAN, also became important, and VC-backed companies played a significant role in this discontinuity. Overall, there were major technological discontinuities, and wireless and Internet businesses started emerging in the middle of our sample period.

There is significant variance in the timing and the level of attention paid by the top management of the companies we studied to these discontinuities. Some of the first incumbents in the sample mentioned the Internet in their annual reports or 10-K filings in 1993-1995, but most did so much later, between 1996 and 2000. For instance, Microsoft introduced its first Internet browser and mentioned the Internet for the first time in its letter to shareholders in Fall 1995, and the Internet was broadly covered in subsequent letters to shareholders. In fact, in its Letter to Shareholders in the 1995 Annual Report, Microsoft declared, "*The largest launch in the history of the PC business, Windows 95 also launches the personal computer in a new role as a platform for the Internet and the world of interactive networks.*" Formal attention to wireless technologies followed a similar pattern. Our sample companies were generally active in different types of interorganizational networks that included alliances and syndicated VC investments. Approximately 40% of the active sample companies had co-investment ties with VCs.

We gathered data on alliances and joint ventures from Thomson Financial's *SDC Platinum* database. Following the social network literature (Stuart 1998; Stuart et al. 1999) in constructing partner status measures based on alliance network positions, we collected information on all alliances between all companies in SDC Platinum to construct full alliance networks without being constrained by our focal partners and their immediate partners. This process resulted in 250,462 alliance ties in 1989-2000. Following the literature on CVC and VC syndication (Dushnitsky and Lenox 2005a; e.g., Dushnitsky and Shaver 2009; Podolny 2001; Sorenson and Stuart 2001, 2008), we used the VentureXpert database to identify incumbents' CVC investments. Again, we wanted to use full syndication networks when calculating partner status measures. We downloaded information on 139,478 VC investments covering the 1989-2000 period. For the dependent variables, we collected 10-K filings from the SEC and several alternative sources (e.g., Lexis-Nexis, Mergent) for those firm-year observations for which the 10-K document was not available in the SEC EDGAR service. We also collected annual reports for all available firm-year observations using a large number of sources, including databases of Thomson Financial, Lexis-Nexis, Mergent, and company websites, among others. In many cases, annual reports were available only as images. In those cases, we

scanned the documents and reproduced the texts of the letters to shareholders with the aid of Optical Character Recognition software, after which the documents were manually inspected and corrected where necessary. Finally, we used Compustat as the source for our financial control variables.

Research Design

We employed both event history analysis techniques and fixed effects panel regression models in analyzing the effects of interorganizational relationships on the timing of top management's attention to technological discontinuities. Event history models are well suited for our purpose because our data are right censored for all firms that did not formally pay attention to technological discontinuities before they were acquired, before they ceased to exist because of a bankruptcy, or before the end of the analysis period. The hazard models employed in event history analyses, reported later, explicitly considered such censoring.

When specifying the hazard model, one can choose from several parametric models or a semiparametric model (Hosmer et al. 2008). The semiparametric Cox model has the advantage of not making strong assumptions about the baseline hazards function. This is important because incorrect parametric assumptions may yield biased estimates of the effects of covariates on the hazard rate (Blossfeld and Rohwer 1995). We analyzed the data using the Cox regression model (Cox 1972), a common choice for analyzing time-to-event data in analogous settings (e.g., Eggers and Kaplan 2009). The formal Cox hazards regression model is

$$h(t) = h_0(t) \exp\{\beta' X(t)\},$$

where $h_0(t)$ is the unspecified baseline hazards function, β is a vector of regression coefficients to be estimated, and X is the vector of covariates. The Cox proportional hazard model does not make any assumptions about the baseline hazard $h_0(t)$. Cox's partial likelihood estimator provides an effective way of estimating β without requiring estimates of $h_0(t)$. However, the Cox proportional hazards model assumes that the hazard rates are proportional. Thus, $h_0(t)$ does not depend on the covariates included in the model. The assumption of proportional hazards in the Cox model was tested without evidence of non-proportionality.

The data on the timing of top management's attention to technological discontinuities were discrete because each corporation was observed annually. This led to ties among companies in the timing of their top management's attention to technological discontinuities. Therefore, we used the Efron method, which is suitable for data with a large

number of ties, but we found no significant differences in the results compared to other choices (Cleves et al. 2004).¹

As additional robustness tests, we reran the duration analysis using discrete-time survival analysis (a logit model with annual year dummies and robust standard errors clustered by firm) and piecewise exponential models with robust standard errors without changes in the main results.

The independent variables used in the hazard models changed over time. To accommodate time-varying covariates, we divided the time period during which each firm was observed into yearly spells (Tuma and Hannan 1984). All time-changing covariates were updated annually. Each annual spell was treated as right censored, except for those spells that terminated in recognizing the technological discontinuity. Our models assumed that interorganizational relationships in year $t-1$ would lead to formal attention by top management to discontinuities in year t . This one-year lag also helped us to ensure the causality of the relationship. Furthermore, for independent variables, we calculated network measures with two-year moving windows. Thus, to explain attention in year t , we used relationships from $t-2$ to $t-1$, except for two robustness test models, in which we tested simple one-year lagged annual measures $t-1$. To account for the potential endogeneity of CVC activity, we estimated two-stage models that predicted co-investments with VCs in the first stage and controlled for this in the second stage of the model, which estimated the effects of interorganizational ties on the timing of top management's attention to discontinuities.

Measures

Dependent Variables: *Timing of Top Management's Attention and Annual Relative Top Management's Attention to Discontinuities.* Our primary dependent variable was the timing of the formal attention to major discontinuities by an incumbent's top management. Following other studies that measured management cognition for a large number of companies over a long period of time (e.g., Barr 1998; Eggers and Kaplan 2009; Gerdes Jr. 2003; Kaplan 2008; Kaplan et al. 2003; Osborne et al. 2001; Schnatterly 2003), we derived the data for the dependent variable from companies' official reports. As a source for our primary measures, we used companies' annual 10-K filings with the Securities Exchange Commission (SEC), as in prior research (e.g., Feldman et al. 2009; Gerdes Jr. 2003; Schnatterly 2003; Yuthas et al. 2002). Official SEC filings, such as Item 1 (management discussion and analysis, MD&A) in annual 10-K filings, have several advantages over other types of corporate documents. They are

¹ We also reran the analyses using as an alternative, the Breslow method, which is the default in Stata (but theoretically less suitable for our situation) and obtained qualitatively similar results for the hypothesized relationships.

comprehensively available, audited, and comparable across firms and over time (Feldman et al. 2009). The comprehensive availability of the documents is important because even a small number of missing documents would make our time-to-attention variable indeterminable. Other potential sources of information, such as letters to shareholders, press releases, or speeches by senior executives, are not available as consistently for all firms in the sample. This factor excluded the use of letters to shareholders in annual reports in the event history models. Internal sources, such as minutes from board meetings, though desirable, would have been nearly impossible to obtain. Although measuring cognitive constructs based upon publicly available documents has limitations (e.g., Fiol 1995; Fiss and Zajac 2006), recent research has shown that these documents reflect judgments about the importance of issues among senior management. As a result, they offer reasonable proxies for senior management's attention that can be constructed through text analysis (Cho and Hambrick 2006; Duriau et al. 2007; Eggers and Kaplan 2009; Kaplan 2008). In additional analyses that explained annual attention by top management using fixed effects panel regression models, we used letters to shareholders as the source of data, with similar results. To operationalize these measures, we used counts of mentions of the Internet (or wireless, in other analyses) divided by the number of words in the document (Item 1, Management Discussion in 10-K in the main analyses and LTS in additional robustness tests).

As stated, we examined two discontinuities that substantially affected ICT companies during the sample period 1989-2000: the Internet and wireless technologies. Both technological discontinuities profoundly affected a large number of industries, redefining how we think about information and communication technologies (Szulanski et al. 2004; Yoffie 1997). As with many other discontinuous technologies, Internet-based and wireless-based businesses were first developed by new entrepreneurial ventures (Christensen 1997). For instance, whereas none of the sample corporations mentioned the Internet in their 10-K filings before 1993, dozens of VCs had made investments in companies that were active in developing technologies relevant for the Internet since the 1980s, according to VentureXpert.

To determine the time when top management paid attention to these discontinuities, we searched the annual 10-K filings of all sample companies over the entire sample period for occurrences of terms commonly used by top management to refer to focal discontinuities within the "management discussion" section that describes the business in the 10-K document (Item 1). We then recorded the year of the first mention of the discontinuity. To examine the

Internet, we focused on the phrase “the Internet,” which consistently referred to the Internet as a discontinuity. To validate our measure, we conducted further content analysis that included key-word-in-context (KWIC) analyses. Although we found that a strict focus on the “the Internet” in 10-K files helped to avoid false positives (such as “Internet Protocol” or “Internetworking,” which were used to refer to technical issues in a small number of documents much earlier than the Internet as a phenomenon was known), we also developed broader measures based on the KWIC analysis and reran the main model including additional words (“Internet”, “Web”, “IP”, “on-line”, “online”, “e-commerce”, and “ e-business”) with substantially similar results.

Thus, our study’s first dependent variable was the time when top management formally paid attention to the Internet in a firm’s corporate documents. This was measured as the time between January 1989 (alternatively, January 1993 in the robustness tests) and the time of a company’s first mention of technological discontinuity in its 10-K filings. We repeated this approach with wireless technologies (e.g., wireless local area networks, WLANs) as a focal discontinuity. Following the same logic we used when studying the Internet, we identified the first mention of variations of the term “wireless” in the 10-K filings and tested the hypotheses with this dependent variable. To measure top management’s attention to wireless technologies, we considered other terms, such as “mobile” and “cellular”, but we found that the word “wireless” was the best choice for this analysis.²

In addition to the first mentions of the focal discontinuities that we used in the event history analyses, we operationalized another dependent variable to measure annual formal attention by top management to these discontinuities as the relative share they received either in the 10-K filings or in letters to shareholders when normalized by document length. We ran several robustness tests that included alternative dependent variables to ensure the validity and reliability of our measurement approach. These tests are presented in the Results section.

Independent Variables. The first independent variable (Hypothesis 1) was *homophilous interorganizational ties* to peer incumbents, measured as the number of alliances or joint ventures with peers in the sample. To construct this variable, we counted all alliances and joint ventures of a focal firm with all other firms in our sample within the

² We found that the word “wireless” was commonly used to refer to the new phenomenon (e.g., Motorola in a December 1990 10-K filing: “...will allow the Company to provide a new group of products to both the current cellular marketplace and the emerging wireless communications market.” and Oracle in a May 1995 filing: “The networks can range from local and wide area networks to ISDN, internet, broadband and wireless.”) In contrast, “mobile” was used for many other purposes, such as referring to mobile users who could log in to wired networks in remote locations (e.g., 3Com in a May 1995 10-K filing: “3Com’s AccessBuilder remote access servers give these mobile users simplified analog or digital (ISDN) dial-up access to the network.”)

same 3-digit industry while excluding direct competitors with a 4-digit SIC code match.³ Our choice of size and industry to capture partner homophily is justified because size is an important yet easily measured criterion to evaluate a firm's available resources. For instance, SMEs in the same industry face very different competitive conditions than large firms do. We further limited the alliances and joint ventures to relationships within the same industry because industry boundaries often shape the mental models of a firm and its top management (Porac et al. 1995). To test Hypothesis 3, we created a measure of *heterophilous interorganizational ties* by counting co-investment ties with VC firms. The idea behind this measure is that by establishing a CVC unit that co-invests with private VC firms, an incumbent firm could connect to the networks of start-ups and VCs. These connections were operationalized through syndicated investments alongside VCs (i.e., the CVC fund in which an incumbent is the sole limited partner co-investing with private VCs, thus creating links between the corporation and VC companies and start-ups). Syndicated investments frequently involve the sharing of information about start-ups, their technologies, and the markets they are likely to serve (Gompers and Lerner 1999; Sorenson and Stuart 2001). Information about emerging technologies typically reaches VC networks early (Bygrave et al. 2001; von Burg and Kenney 2000).

To test Hypotheses 2 and 4 on the effects of partners' status in homophilous and heterophilous ties, we first created measures for partner status in homophilous and heterophilous ties. To measure status in alliance networks and VC syndication networks, respectively, we followed Podolny (1993; 2001; 2005) in using Bonacich's (1987) centrality measure. The Bonacich centrality $c_i(\alpha, \beta)$ was defined as

$$c_i(\alpha, \beta) = \sum_j (\alpha + \beta c_j) R_{ij}$$

where R_{ij} was an element of the relational matrix R , and each element of R was the number of companies in which firms i and j had invested together (or alliances between the companies, in alliance networks). β was the degree to which the centrality of i is a function of the centralities of other firms. β was the radius of the influence of i . If we did not expect the VC syndication or alliance relationships of j to directly benefit i , β should be small. We followed earlier studies and set β as three-quarters of the reciprocal of the largest eigenvalue of R (Podolny 1993; Sorenson and Stuart 2001).

³ We also reran the analyses without this limitation in the same industry to test the effects of the industry limitation on the effects of alliances with incumbents without significant differences in the results.

For alliance relationships, we calculated the partners' Bonacich's centrality measures using the position of every alliance partner in the full network formed by all alliances established in the specified moving window. In our analyses, we chose two years, but we also tested other windows without a significant difference in results. We then aggregated the partner measures for focal firms by averaging across all partners with which a focal firm had formed alliances or joint ventures in a given year. For the CVC co-investments with VCs, we calculated the centrality of all VCs with which a focal firm had co-invested in the given moving window (two years in reported analyses, except for two reported robustness tests with one-year windows) using the full VC syndication networks. We then averaged these values to arrive at an aggregate value.

The results of this measurement approach appear valid. Examining the data shows that in 1994, for instance, Microsoft had one of the highest partner status values in heterophilous ties in the sample based on this measure because it co-invested with Kleiner Perkins Caufield & Byers (the most central private VC in our data that year) and other top-tier VCs.

Control Variables. The analyses also included several firm- and industry-related control variables. We controlled for top management's future orientation based on a text analysis of letters to shareholders or 10-k filings, following the operationalization of Yadav et al. (2007), based on the use of the wording "will" in those documents. Top management's future orientation could influence both the attention they paid to discontinuities and the tools they used to facilitate timely attention (e.g., CVC).

We also captured incumbents' investments in R&D as a measure of how much weight companies gave to technology and innovation issues. To separate R&D effects from company size effects, we used R&D intensity (i.e., the firm's R&D expenditure divided by its annual sales) instead of using R&D expenditure directly.

We further controlled for firm size and profitability. We measured company size as the logarithm of a company's annual revenues (in millions of US dollars), derived from *Compustat*. Size may influence the timing of senior executives' attention to technological discontinuities because larger firms may have formal, dedicated units to follow such changes. Profitability was measured as the return on assets (ROA) because past performance might influence a company's environmental scanning and CVC investments.

In addition to these firm-level controls, we controlled for industry differences by dummy coding a firm's industry by its three-digit SIC classification. Dummy codes were developed for the SIC 366 (communications

equipment), SIC 367 (electronic components and accessories), and SIC 737 sectors (computer programming, data processing, etc.). SIC 357 (computer and office equipment) served as the reference industry class. Finally, in the duration models, the piecewise constant proportional hazards specification of the models controlled for the increasing adoption of the Internet over time by changing annual baseline hazard rates. In discrete-time duration analyses that we ran as robustness tests and in fixed effects panel regressions, we applied year dummies. We lagged time-varying independent and control variables by one year to reduce the risk of reverse causality.

Results

Table 1 presents the correlations and descriptive statistics for the study's variables. As the data in Table 1 show, the correlations between the independent and the control variables were low to moderate. VIF statistics were also low (below 2) in comparison to the typically used threshold of 10, suggesting that multicollinearity was not a problem in our analysis.

[Insert Table 1 about here]

We used event history analyses to test the hypothesized relationships between interorganizational relationships and the timing of top management's attention to discontinuities. Model 1 in Table 2 reports the base model using Cox proportional hazards regression to explain the time-to-attention to the Internet. Only the communications equipment industry dummy was weakly significant (negative). Other control variables were not significant. Model 1, like all other models, included the inverse Mill's ratio that is used to control for the potential endogeneity of CVC investments syndicated with VCs.⁴ This ratio was also not significant.

[Insert Table 2 about here]

Hypotheses 1 and 3 are tested first in Model 2, with the first mention of the Internet as the dependent variable. Hypothesis 1 predicted that focal firms' heterophilous ties to peer incumbents would have a negative effect on top management's timely attention to technological discontinuities. As noted in Model 2, the coefficient for homophilous ties is negative but insignificant. These results failed to support our hypothesis. Additionally, the results

⁴ In the selection model, we estimated the inverse Mill's ratio based on a probit model explaining whether the focal company engaged in syndicated CVC investments in a particular year. The independent variables included top management's future orientation (t-1), sales (logged, t-1), R&D intensity (t-1), a dummy for missing R&D data, (t-1), return on assets (ROA, t-1), whether the focal company engaged in syndicated CVC investments in the previous period, year dummies, and industry dummies. Of these variables, sales, R&D intensity, ROA, and past CVC activity were all positive and significant. Additionally, some of the year and industry dummies were significant.

concerning Hypothesis 3, which predicted a positive effect on heterophilous interorganizational ties to VCs, failed to provide support for the hypothesis.

Model 3 is similar to Model 2 but adds the partner status measures for Hypotheses 2 and 4. Concerning the predicted negative effect for partner status in homophilous interorganizational ties in Hypothesis 2, the coefficient is insignificant. Hypothesis 4, which predicted a positive relation between partner status in heterophilous interorganizational ties and timely attention by top management to discontinuities, received strong support; the partner status measure is positive and significant.

In Model 4, we sought to ensure that our findings were not influenced by the varying importance of the Internet for our sample companies because some companies did not recognize the Internet in their 10-K filings during the sample period (these companies mostly exited from the sample before the end of the period because they had been acquired by or merged with another company or defaulted). Consequently, in Model 4, we limited the sample to incumbent companies that, at some point during the time period, recognized the Internet in their 10-K filings. The main results of Model 3 remained strong when the analysis was limited to this subset of companies. In additional unreported robustness analyses, we replicated Model 4 using a discrete-time competing risks model in which we identified firms that had exited our sample before the right censoring in 2000 without recognizing the Internet in their filings (usually by being acquired or after ceasing operations because of poor performance). The main results remained strong, but homophilous ties increased the hazard of exit from our sample (i.e., increased the risk of business failure). In unreported robustness tests, we ran a discrete-time duration model with self-selection correction (equivalent to Model 3). The results were qualitatively similar to those obtained in Model 3, reaffirming the robustness of our finding that the status of partners in heterophilous ties is important. Furthermore, we ran a piecewise exponential model and obtained similar results. In Model 5, we repeated Model 4 using only one-year lagged annual network measures instead of a two-year moving window to focus the analyses on very recent network ties that are likely to be particularly relevant for learning about discontinuities. The results were similar to those reported.

To ensure that our results were robust across different ways of defining and measuring top management's attention to discontinuities, we devised another operationalization based on annual weighted counts of mentions in 10-K filings. This is a common measurement approach in other empirical research on the attention-based view when attention is used as an independent variable explaining organizational responses (Eggers and Kaplan 2009; Kaplan

2008; Kaplan et al. 2003). However, it should be noted that this continuous measure of the strength of attention is conceptually quite different from our hypotheses and primary analyses focusing on the time to attention. Therefore, we consider this complementary evidence. Model 6 in Table 2 reports our results using a fixed effects panel regression that explains the relative frequency of mentions of the Internet in 10-K filings. This model shows that the status of partners in heterophilous ties has positive and significant coefficients, supporting Hypothesis 4. Other hypotheses are not supported, although the coefficient for Hypothesis 1 is in the hypothesized direction. These results are consistent with those obtained in the event history models. Furthermore, increasing our confidence in the main finding about the positive effect of partner status in heterophilous ties on top management's attention to discontinuities, we observed the same result also when operationalizing the measure using letters to shareholders instead of 10-K files in unreported robustness analyses.

As explained in the methods section, to help generalize our findings and to ensure that these findings are not idiosyncratic to one particular discontinuity, we considered another important discontinuity in the ICT sector, wireless technologies. The results reported in Models 7-12 were similar to and supportive of our main findings based on time-to-attention to the Internet. However, one qualitative difference in the results was that Hypothesis 1 received support in Model 11. Although the results were very similar, we consider the Internet the primary setting for our hypotheses because wireless technology was a less significant discontinuity than the Internet was during this time period. For instance, the adoption of wireless technologies occurred over a significantly longer period of time, with some companies paying attention to wireless in 1989-1990, but fewer companies paying attention to it at the end of the sample period. Thus, wireless technology is a secondary setting for our hypothesis tests.

Our analyses suggested that homophilous ties did not consistently have the expected significant negative effect on timely attention to discontinuities by top management. Therefore, we decided to further explore this relationship. Because the firms in our sample gradually paid increasing attention to the Internet and wireless technologies, one possible explanation for the lack of significance might be the changing effect of peer incumbents over time. In the beginning, when peer companies do not pay attention to emerging discontinuities, they may be expected to have an inertial negative effect. However, as incumbents increase their attention to the discontinuity, they may become advocates of this discontinuity, and their influence on other incumbents that have not paid formal attention to the discontinuity might change. In fact, once the top management of peer incumbent firms have paid

attention, it is difficult to argue that they would continue to have an inertial effect. Instead, their effect could become positive from the perspective of a focal company that has not yet paid attention. Consequently, we ran an unreported post hoc analysis of this potential explanation by dividing annual homophilous ties based on whether the top management of the partner incumbent paid attention to the discontinuity. In the panel data analysis in the Internet case, we found that before the partner had paid attention, the effect was negative, and after the partner had paid attention, the ties had a positive effect, which weakly supports Hypothesis 1. We consider this finding interesting and a logical partial explanation for our insignificant results in the primary tests of Hypothesis 1. At the same time, we note that the evidence is quite weak and not replicable in our event history analyses or in the wireless case. A proper test of the moderating effect of peer attention on the effect of homophilous ties would require a different research setting that includes controls for other channels (e.g., competitor intelligence) through which incumbents learn from each other.

Discussion

In this study, we aimed to examine the role of different types of interorganizational ties and the status of partners within these ties as structural antecedents of top management's attention to emerging technological discontinuities. We tested our hypotheses in a longitudinal study of the incumbents in four information and communications technology industry sectors, examining their ties in full alliance and VC networks. We found that the status of partners in heterophilous ties formed through co-investments with high status VC firms was a significant predictor of timely attention to such discontinuities by top management. Homophilous ties did not have a consistently significant effect, but our ex post analysis suggested that this result might be due to the changing effects of peers when their top management begins to pay attention to a given discontinuity. Our findings contribute to several bodies of literature, as discussed next.

Technological Discontinuities and Top Management's Attention

A growing body of research on technological discontinuities highlights the role of the attention of incumbent firms' top managers in responding to discontinuous technological change (e.g., Barr 1998; Kaplan 2008; Kaplan and Tripsas 2008; Tripsas and Gavetti 2000; Virany et al. 1992). For instance, in work on discontinuities in fiber optics and pharmaceuticals, Kaplan and colleagues (Eggers and Kaplan 2009; Kaplan 2008; Kaplan et al. 2003) have shown

that top management's attention predicts effective firm responses. By interpreting changes in the external environment and formulating (or at least orchestrating the formulation of) appropriate and timely responses, top managers can shape a firm's strategy. However, prior studies have not addressed the question of why top managers in some firms pay attention to these discontinuities whereas top managers in other companies do not.

Prior research has explained the failure to pay attention to discontinuities largely by invoking cognitive and incentive factors that work against timely attention by top management to technological discontinuities. These discontinuities are often based on knowledge that is distant from the incumbents' existing knowledge base (Kaplan and Tripsas 2008) and therefore may lead to business models that directly contradict the experience of a firm's senior executives (Tripsas and Gavetti 2000). In some cases, technological discontinuities may also run counter to deeply held beliefs within the firm that form the organization's identity (Tripsas 2009). As a result, environmental cues about these discontinuities are easily misinterpreted by top management (Barr 1998; Porac et al. 1995; Reger and Palmer 1996; Tripsas and Gavetti 2000). Furthermore, top management frequently has personal incentives to not embrace such discontinuities because of the risks of investing in unproven new technologies (Kaplan 2008; Kaplan and Henderson 2005).

Our results suggest that some of the interorganizational relationships in which incumbents engage can play a crucial role in guiding their top management's attention to technological discontinuities. Indeed, we find that heterophilous ties with high-status partners through co-investments with high-status VCs positively affect top managers' timely attention, whereas homophilous interorganizational relationships do not have a significant impact in this regard. These results extend prior arguments in the social network literature that posit that access to diverse sources of information should be positively related to the ability to adapt to environmental change (Koka and Prescott 2008; Lee 2007). Our results suggest that in addition to the diversity of the information sources, the status of an information source plays an important role because knowledge and information from these sources carry different weights with corporate decision makers. The high status of partners in heterophilous ties, such as syndication with high-status VCs, may increase the credibility that top managers attach to information from these ties.

Attention-based View of the Firm

Our results also contribute to the attention-based view of the firm. In particular, the literature on the attention-based view has noted the importance of structural determinants of organizational attention. For instance, Ocasio (1997) argues that it the rules of the game, resources, players, and social positions within the firm generate a set of values that order the legitimacy, importance, and relevance of issues and possible organizational responses to these issues. However, prior theorizing in the attention-based view has been largely restricted to structures within organizations. Our study extends this research by emphasizing structures outside of a firm's boundaries that might influence top management's attention. Our core finding, that heterophilous interorganizational relationships with high-status partners affect top management's attention to technological discontinuities, suggests that such structures can play an important role in shaping attention patterns. As a result, theorizing within the attention-based view should be extended to include structures beyond the boundaries of the firm. Decision makers in organizations are embedded in multiple interorganizational structures that may influence their attention patterns.

Our core finding, that heterophilous interorganizational relationships with high-status partners affect top management's attention, further suggests a theoretical link between the literature on attention and the literature on status, which warrants additional theoretical and empirical work. Status and status expectations influence relationship formation across organizations (Chung et al. 2000) and are central to intraorganizational group formation processes (Ruef et al. 2003) and interactions during task performance (Ridgeway 2001) within these groups. In the context of the present study, status expectations may influence how executives in high-status industrial corporations relate to high-status or low-status VCs with whom their firm co-invests and, consequently, how they evaluate information from these VCs. Although our empirical results are limited to the effects of status within heterogeneous interorganizational relationships, status differentials may be important theoretical explanations for attention allocation processes in intraorganizational contexts. Status expectations may shape the structures that affect attention allocation and may have important effects on interaction patterns within intraorganizational social structures.

The link identified in this study between status and attention may also shed light on bottom-up attention processes (Ocasio, 2011). The decision makers in the firms we studied are faced with an ecology of information regarding new technologies that compete for attention. Given the uncertainty regarding these technologies, decision makers sometimes find it difficult to evaluate this information based upon its quality (Podolny 1993, 1994; Podolny

2001) and may therefore revert to the status of the sources to determine the salience of the information. In this view, status moderates bottom-up processes of attention allocation.

In our empirical analyses, we failed to find consistent support for the hypothesized effects of homophilous relationships. However, our post hoc analysis, which divided homophilous relationships into those with partners that paid attention to discontinuity and those that did not pay attention to discontinuity, suggests that situational factors (in this case, the fact that a partner had paid attention to the discontinuity) may interact with structures that guide attention allocation. Although tentative given the limitations of our data, this finding suggests the need to further explore how the interaction of structural and situational factors could affect attention allocation processes.

Our findings further contribute to recent research on attention to rare events (Rerup 2009; Weick and Sutcliffe 2006). This research has argued that maintaining sufficient quality of attention to emerging rare events is challenging, particularly in light of short-term pressures that arise from ongoing routine activities that may exhaust organizational attention structures (Levinthal and Rerup 2006; Salvato 2009). Regular, focused discussions with a select group of high-status VCs may create a context in which top managers' attention focuses on rare events, freeing discussions from the short-term pressures of routine business development and allowing them to focus on emerging technologies and business models. These regular discussions can increase the quality of attention and facilitate mindful exploration of potential discontinuities by the top management team (Ocasio 2011; Salvato 2009). By regularly interacting with high-status VCs, top managers may create a mechanism that routinizes the mindful exploration of weak signals and allows them to overcome the trade-off between routine and mindful behavior (Levinthal and Rerup 2006; Salvato 2009).

Interorganizational Networks

Our analyses offer a fine-grained picture of the roles of network structure and network composition in social networks. Scholars generally agree that, under most circumstances, social networks formed through interorganizational relationships provide benefits to the focal firm (Burt 1992; Coleman 1988; Podolny and Stuart 1995; Powell et al. 1996). However, there is a debate about the type of network that provides the most benefits. This debate has focused on the structures of various networks, emphasizing the different benefits derived from sparse and dense networks

(Burt 1992; Coleman 1988; Lee 2007) and largely ignoring the differences among the firms with which a focal firm connects in a network.

A considerable amount of prior literature on social networks has viewed (or, at least, empirically treated) all nodes in a network as equal. However, some researchers have recently underscored the importance of network composition in explaining the different effects of networks to which a focal firm is connected (Lee 2008). Our finding that heterophilous ties through co-investments with high-status VCs have a consistently significant positive effect on timely attention by top management, whereas homophilous interorganizational ties through alliances to industry peers have no such univocal effect, further emphasizes the importance of network composition. Our analysis of full alliance and VC syndication networks suggests that treating all nodes in a network as equal or focusing solely on network structure can lead to inconclusive or even misleading results. In particular, the inconclusive finding regarding homophilous ties is interesting. Our post hoc analysis suggests that homophilous ties seem to have initial inertial effects, whereas these ties seem to have positive effects when partner firms pay attention to discontinuity. This finding, albeit tentative, suggests that some effects of social networks are likely to be dependent on differences across nodes that may not be fully captured by network structure measures. The results also suggest that treating all interorganizational relationships as one social network in which the firm is embedded may oversimplify reality and mask some of the effects of social networks. Future theorizing would benefit from distinguishing between the multiple networks to which a firm is connected. Different networks serve different purposes and consist of different types of actors, which may have different effects on the focal firm. Such fine-grained theorizing will create more realistic models of how social networks influence firm behavior and its outcomes.

Corporate Venture Capital

Our results contribute to the literature on the role of CVC in the corporate innovation process. Although it is somewhat cyclical in volume, CVC investing has become an integral tool of corporate innovation activities (Dushnitsky 2006; Dushnitsky and Lenox 2005a). Prior research on CVC investments has examined the potential learning benefits of these investments (Dushnitsky and Lenox 2005b; Dushnitsky and Shaver 2009; Schildt et al. 2005; Wadhwa and Kotha 2006). Early research has explored the effect of CVC investments on innovation rates (Dushnitsky and Lenox 2005b) and on exploratory knowledge creation and learning (Schildt et al. 2005; Wadhwa and Kotha 2006) by linking

these investments to patenting rates. More recently, studies have pointed to the limits of knowledge transfer between start-ups and incumbents (Dushnitsky and Shaver 2009), suggesting that incumbents' CVC investments might fail in circumstances where learning might be most valuable for the incumbent. Overall, these findings question the importance of CVC for corporate innovation.

Our study contributes to this debate by showing that the role of CVC activities in corporate innovation might be related less to transferring patentable knowledge to the parent firm and more to directing top management's attention to major changes in the firm's environment. CVC can thus be viewed as radar that identifies and highlights emerging technologies and new businesses (Dushnitsky and Lenox 2006; Keil et al. 2008a; Siegel et al. 1988). As such, CVC investments can significantly influence the cognizance of business opportunities and related business models among CVC managers and top managers. Even when an incumbent does not transfer a specific technology that a start-up can commercialize, CVC investments may provide important insights into the evolution of a technological field. Information received from CVC investments may also influence how senior executives think about the likelihood that a technological area will become important for the incumbent. These higher-level learning processes are not always influenced by the individual start-ups in which the incumbent invests. Instead, they are shaped by the information CVCs receive in the process of screening ventures together with high-status VCs and the portfolio of deal proposals they process for investment purposes together with syndicating VCs. For instance, although Microsoft did not directly invest in the first Internet start-ups around 1994, its top-tier co-investor, Kleiner Perkins Caufield & Byers, was a lead investor in pioneering Internet start-ups such as Netscape in early 1994. Among the incumbent firms in our sample, Microsoft was one of the early companies to pay attention to the Internet, with the Internet clearly identified as a key business driver in the letter to shareholders of the 1995 annual report. Although co-investment relationships of corporations in CVC investments with high-status VC firms may not necessarily create direct knowledge flows about the VCs' other portfolio companies, emerging business opportunities and start-ups in which high-status fellow board members or their VC partnerships are publicly investing are likely to receive more attention by fellow board members than are other start-ups of similar size or potential business opportunities of similar uncertainty. Among corporate tools for recognizing discontinuous technological change, a large number of indirect ties to promising VC-backed start-ups through co-investments with top-tier VCs is a unique feature of co-invested CVC investments compared to other interorganizational relationships.

Given our results, it is reasonable to ask why CVC investment, a corporate activity that is often relatively small in scale and detached from the core business, plays such an important role in influencing senior management's cognition. One explanation can be found in the theory of knowledge brokers (Hargadon and Sutton 1997; Hargadon 2002). CVC managers are often uniquely positioned to participate in both the corporate environment and the start-up and VC communities (Keil et al. 2008a). By operating in both environments simultaneously, CVC managers are well positioned to act as knowledge brokers who mediate and address cognitive conflicts that arise between the cognitive frameworks of existing business unit managers and frameworks related to technological discontinuity. Overall, our analyses show that CVC activities may play a unique role by providing a window on technological discontinuities.

Managerial Implications

Our results have several implications for managerial practice. They suggest that to avoid being trapped in the innovator's dilemma (Christensen 1997; Rosenbloom and Christensen 1994), incumbents must develop relationships that can direct their top management's attention to these discontinuities. The results emphasize that incumbents can create a radar for technological discontinuities by actively using syndicated CVC investments with top-tier VCs to monitor emerging developments in start-up networks. Technologies developed by start-ups are often the forerunners of technological shifts in an industry. Building relationships to such start-ups and the investors that fund them can direct top managers' attention to technological discontinuities. However, the effectiveness of this tool depends on an incumbent's ability to co-invest with the highest-status VCs. Consequently, incumbents need to structure their investment activities in ways that enable cooperation with high-status VCs. Executives must think strategically about their CVC activities by setting clear investment goals. For instance, executives must identify the types of technological trends their companies should follow and how to best position their companies in VC networks to follow these trends.

When considering the costs and benefits of CVC for corporations, it is worth noting that although CVC requires capital to be committed, each investment in a syndicate with independent VCs should have a positive risk-adjusted return expectation as a stand-alone investment. With a long-term commitment to CVC investment activity, the strategic benefits gained from these investments should be relatively cheaper in comparison to corresponding benefits from R&D expenditures and other activities that create direct expenses.

Limitations

Our study has limitations that should be recognized when interpreting its results. Specifically, our measurement approach forces us to abstract from the interpretative processes in which top managers engage as they address technological change in their environment (Lant and Shapira 2001). However, the approach we have followed is in line with similar studies that measure cognitive constructs across a large number of organizations over a long period of time. A word count-based measure might be one of the few ways to capture issues of managerial cognition in large sample studies (Eggers and Kaplan 2009; Kaplan 2008).

Because we construct our attention measure using letters to shareholders and 10-K reports, we are unable to measure valence as an opportunity or threat or to measure the specific nature of the understanding. Although valence and specific understanding would be of theoretical interest, the methods we use have been found to be significantly weak in assessing such constructs (Fiol 1995). Therefore, we must leave the issue of valence to future research.

Our sample was drawn from four information and communications technology industry sectors, providing an interesting setting in which to examine a technological discontinuity such as the Internet. Companies in these industries are expected to be well positioned to recognize the strategic importance of the Internet (and wireless technologies in the robustness analysis). Our industry choice enabled us to select a sample of firms that were similarly affected by the same discontinuities. Because industries differ in their knowledge bases as well as in their rate and sources of technological change and because the evolutionary paths of technologies might differ, the results may not apply to other industries. Thus, constructive replications of our study in other industry settings and for other technologies may yield a richer understanding of how CVC investments can support incumbents' early recognition of technological discontinuities.

A final limitation concerns our approach to measuring the networks in which our focal firms were embedded. To make the analysis manageable, our analysis of network structures focused exclusively on direct ties and partners' status in alliance and VC networks while ignoring information flows through indirect ties. Future research should explore the effects of such indirect ties in datasets that are smaller in size and therefore more manageable.

Directions for Future Research

Our results highlight several avenues for future research. Future researchers should study different network compositions in more detail and should develop a more detailed picture of the effects of the multiple social networks in which an incumbent is embedded. Although we were able to distinguish between peer alliances and CVC co-investments with high-status VCs, other distinctions can be made and should be incorporated into future social network studies. Researchers should also explore the time-varying effects of peer alliances that we identified.

Our results suggest that external structural determinants are an important factor in guiding organizational attention to environmental events. Future research could analyze the role of other external determinants of management attention, such as research consortia, trade associations, or board interlocks. Future research would benefit also from investigating how internal and external determinants interact to shape organizational attention. This research would not only advance understanding of attention structures but would also provide important findings for the design of organizational issue management systems.

Our findings highlight a need for more fine-grained research into the processes used by incumbents to capture knowledge and information from CVC investments and the deals they screen. The ways that incumbents gather, analyze, and interpret information about pending technological changes are issues worthy of investigation. The systems and processes that incumbents employ for these purposes also require further study. It is essential to investigate the processes that incumbents employ to make effective use of information in designing their strategies. A related issue for future research involves the different mechanisms incumbents apply to identify technological discontinuities.

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Table 1 Descriptive Statistics and Correlations

Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1 Attention paid to the Internet t	0.201	0.610	0.000	5.860									
2 Attention paid to wireless t	0.418	1.304	0.000	16.351	0.016								
3 Homophilous interorganizational ties $t-2-t-1$	0.654	2.461	0.000	22.000	-0.007	-0.059							
4 Status of partners in homophilous ties $t-2-t-1$	45.879	171.444	0.000	1536.567	-0.007	-0.049	0.582 *						
5 Heterophilous interorganizational ties $t-2-t-1$	7.511	45.674	0.000	886.000	0.168 *	0.072	0.021	0.016					
6 Status of partners in heterophilous ties $t-2-t-1$	83.485	233.326	0.000	1588.176	0.276 *	0.125 *	0.067	0.057	0.390 *				
7 Top management's future orientation $t-1$	1.813	1.440	0.000	9.300	0.007	-0.025	-0.028	0.007	-0.023	-0.008			
8 Firm size $t-1$	7.068	1.521	-4.423	11.380	0.084 *	-0.036	0.377 *	0.252 *	0.222 *	0.347 *	-0.019		
9 R&D intensity $t-1$	0.076	0.060	0.000	0.453	0.116 *	0.103 *	0.020	-0.021	0.023	0.143 *	0.126 *	0.091 *	
10 Firm profitability $t-1$	0.044	0.356	-1.305	8.590	0.019	0.002	-0.008	-0.021	0.022	0.041	-0.043	-0.031	-0.064

Notes. Firm-year observations in Models 6 and 12. * $p < .05$.

Table 2 Top Management's Attention to Discontinuous Technological Change

	Model 1 Internet 1 st mention	Model 2 Internet 1 st mention	Model 3 Internet 1 st mention	Model 4 Internet 1 st mention	Model 5 Internet 1 st mention	Model 6 Internet Mentions	Model 7 Wireless 1 st mention	Model 8 Wireless 1 st mention	Model 9 Wireless 1 st mention	Model 10 Wireless 1 st mention	Model 11 Wireless 1 st mention	Model 12 Wireless Mentions
H1. Homophilous interorganizational ties $t-2-t-1$		-.095 (.078)	-.070 (.089)	.061 (.049)	.089 (.081)	-.004 (.022)		-.075 (.086)	-.002 (.062)	-.200 (.192)	-.206 * (.096)	.000 (.019)
H2. Status of partners in homophilous interorganizational ties $t-2-t-1$			.000 (.001)	-.001 (.001)	.001 (.001)	.000 (.000)			-.002 (.002)	.003 (.004)	.001 (.002)	.000 (.000)
H3. Heterophilous interorganizational ties $t-2-t-1$		.004 (.004)	.002 (.004)	-.004 (.004)	-.004 (.007)	.001 + (.001)		.003 (.003)	.001 (.003)	.000 (.006)	-.005 (.011)	.001 (.001)
H4. Status of partners in heterophilous interorganizational ties $t-2-t-1$			.001 * (.001)	.001 * (.001)	.002 * (.001)	.000 ** (.000)			.001 ** (.001)	.003 ** (.001)	.005 ** (.002)	.000 + (.000)
Top management's future orientation $t-1$	-.032 (.109)	-.006 (.108)	.004 (.112)	.117 (.108)	.104 (.110)	-.033 (.030)	-.151 (.124)	-.152 (.128)	-.152 (.123)	-.077 (.119)	-.080 (.123)	-.014 (.029)
Firm size $t-1$	.092 (.191)	.328 (.265)	.395 (.261)	-.295 (.297)	-.327 (.301)	-.139 (.148)	.260 (.227)	.348 (.241)	.443 * (.224)	.546 (.355)	.583 (.355)	-.017 (.094)
R&D intensity $t-1$	.911 (3.017)	1.974 (3.324)	2.330 (3.329)	.259 (4.591)	-.149 (4.808)	-.126 (1.458)	8.240 ** (1.937)	8.550 ** (2.041)	8.827 ** (1.956)	3.267 (2.316)	3.810 (2.500)	5.938 (3.784)
Firm profitability $t-1$	.102 (.147)	.158 (.155)	.157 (.158)	.602 (.996)	.827 (1.052)	-.068 (.072)	-.058 (.357)	-.056 (.436)	-.131 (.645)	-.621 (2.041)	-.156 (2.079)	.012 (.070)
Industry dummy: communications equipment	-1.072 + (.557)	-.986 (.609)	-.870 (.605)	-.799 (.543)	-.542 (.562)		2.475 ** (.536)	2.478 ** (.543)	2.698 ** (.575)	1.210 (.749)	1.127 (.742)	
Industry dummy: electronic components	-.620 (.433)	-.700 (.458)	-.714 (.457)	-.757 + (.430)	-.547 (.436)		1.601 ** (.469)	1.560 ** (.477)	1.744 ** (.501)	.663 (.611)	.589 (.679)	
Industry dummy: software	.295 (.370)	.390 (.382)	.423 (.385)	-.057 (.437)	.084 (.447)		.836 + (.478)	.803 + (.484)	.898 + (.490)	.413 (.621)	.324 (.674)	
Inverse Mill's ratio $t-1$	-.418 (.343)	-.137 (.494)	.116 (.468)	-.358 (.480)	-.263 (.477)	-.136 (.095)	.168 (.370)	.289 (.391)	.591 + (.328)	1.630 ** (.500)	1.623 ** (.539)	-.043 (.113)
Year dummies						Incl. 1.746 (1.262)						Incl. .552 (.740)
Constant												
Observations	557	557	557	276	276	693	524	524	524	195	195	693

Notes. Models 1-5 explain the hazards for corporations to pay attention to the Internet in the 10-K filing Item 1 business for the first time during an annual spell. Models 7-11 repeat this for wireless. In these models, positive coefficients indicate greater hazard, i.e., earlier attention. Models 1-5 and 7-11 are Cox proportion hazards models with time-varying regressors and robust standard errors. Models 4-5 and 10-11 limit the sample to companies that eventually pay attention to the discontinuity. Models 5 and 11 use one-year windows ($t-1$) for hypothesis variables instead of the two-year windows ($t-2-t-1$) in all other models. Models 6 and 12 are fixed effect panel regression models explaining normalized counts of the mentions of discontinuities in 10-K management discussion sections (number of mentions divided by the number of words in the document * 1000). Robust standard errors in parentheses. ** $p < .01$, * $p < .05$, + $p < .10$, two-tailed tests for control variables, one-tailed tests for directional hypotheses.