SMALL-WORLD NETWORKS, ABSORPTIVE CAPACITY, AND FIRM PERFORMANCE: EVIDENCE FROM THE U.S. VENTURE CAPITAL INDUSTRY

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ABSTRACT

A small-world network is a locally clustered network with short path lengths connecting different clusters. In this study, we explore contingent factors that affect the impact of small-world networks on firm performance, maintaining that benefits from such networks may depend on a firm's absorptive capacity to recognize and assimilate external information and knowledge. Using a sample of U.S. venture capital (VC) firms from 1995-2003, we find that small-world networks have a positive impact on firm performance and this positive impact varies with multiple determinants of a firm's absorptive capacity. Implications of these findings for organizational learning and interfirm network studies are discussed.

Key Words: Interfirm networks; small-world networks; venture capital industry; firm performance; organizational learning

The small-world phenomenon, highlighted in the seminal work of Milgram (1967), refers to the fact that strangers who appear to be disconnected from each other are in fact connected through only a few intermediary links. Given the unique properties of small-world networks, there has been growing interest in sociology and organization studies in the small-world phenomenon. Studies have not only examined the phenomenon's structural nature, but also the behavior and performance consequences of small-world networks (Baum, Shipilov and Rowley, 2003; Davis, Yoo and Baker, 2003; Fleming, King and Juda, 2007). The research on the performance implications of small-world networks, however, report mixed results (Uzzi, Amaral and Reed-Tsochas, 2007), with some reporting a non-significant effect while others reporting either linear or non-linear effects of small-world networks on certain performance variables. The inconsistent findings about the impact of small-world networks on performance suggest a need for more evidence about how small-world networks affect organizational outcomes, especially firm performance. In addition, these inconsistent findings suggest possible contingencies through which small-world networks exert their impact. Yet, previous research has not given sufficient attention to contingent factors that may influence the impact of small-world networks.

To fill these gaps, this study was designed to examine how a firm's absorptive capacity influences the impact of small-world networks on performance. As defined by Cohen and Levinthal (1989, 1990, 1994), absorptive capacity is a firm's ability to recognize the value of new external information and knowledge, assimilate it into existing organizational routines and apply it to improving performance. We submit that while small-world networks can improve firm performance in general, the performance of firms that are able to value, assimilate and apply new external information and knowledge (i.e., firms with high absorptive capacity) is likely to improve more.

The importance of examining the moderating role of a firm's absorptive capacity resides in the fact that the most important benefit of small-world networks is their rapid transmission of new

information and knowledge (Schilling and Phelps, 2007; Uzzi and Spiro, 2005). Whether and how different actors benefit differently from small-world network effects may be determined by their different capacities to value and assimilate new information and knowledge from their networks. A firm's absorptive capacity can directly affect how it screens and utilizes available information, which certainly should affect its performance. This study was designed to elucidate any link between small-world networks and firm performance through a firm's absorptive capacity and to reveal in greater detail mechanisms through which firms garner strategic benefits from their small-world networks.

Examining the contingent role of small-world networks may increase our understanding of how firms manage their various resources in a networked environment. The small-world network in which a firm is located to a large extent reflects the external environment that the firm faces, characterized by the network patterns among different firms. Prior research on small-world networks have largely ignored participants' efforts to manage the network environment, whereas the current study regards networked firms as adaptive systems, actively using their resources and capacities to interact in a particular environment (Cyert and March, 1963). Also, focusing on a firm's absorptive capacity, which involves its past experiences (Cohen and Levinthal, 1990), can increase our understanding of how a firm's past experience helps it to adapt to an environment characterized by the particular properties of small-world networks.

We test our theoretical propositions in the context of the U.S. venture capital market. The venture capital market has been used previously as the empirical context for studies of interfirm networks (Podolny, 2001; Sorenson and Stuart, 2001). Previous research in this context has not given much attention to the possible influences of the overall network patterns of the industry. The current study explores network factors that might affect the performance of venture capital firms, which could have significant theoretical as well as practical implications.

This paper is structured as follows:

We first provide an overview of the venture capital market in the United States. We then develop theories and hypotheses after reviewing the extant literature on the impact of small-world networks on firm performance and firm absorptive capacity. Finally, we present an empirical study of small-world networks and firm performance using data on U.S. venture capital firms from 1995 to 2003. We conclude by considering the implications of these results on existing theories of interfirm networks and firm performance.

The Venture Capital (VC) Market in the U.S. and the Performance of VC Firms

The venture capital (VC) industry has grown radically in size and sophistication over the past 40 years in the U.S. The amount of investment by VC funds increased from about $424 million in 1978 to about $21 billion in 2004 (Gompers and Lerner, 2001; *MoneyTree Survey*, 2004). The VC market also experienced dramatic ups and downs, as indicated by the fluctuating numbers of VC firms in the market and the variations in the numbers of investment rounds completed from 1995 to 2003 (see Figure 1, based on information from the Thomas Financial Venture Economics Database).

--------Insert Figure 1 about here--------

Venture capitalists serve as "brokers" between firms and outside investors, raising funds (primarily from institutional investors) and then functioning as limited partners in a portfolio of companies (usually entrepreneurial start-up companies) in which they invest (Sahlman, 1990). A venture capital firm typically manages one or more VC funds.

The main goal of a VC firm is neither to run the daily business of the entrepreneurial firms, nor to maintain permanent ownership control of the firms. Rather, its main goal is to make quick returns from the growth and increased value of the firm in which it has invested (De Clercq, Fred, Lehtonen and Sapienza, 2006). Therefore, VC firms aim at initial public offerings (IPOs) of the firms in which they have invested, and they receive stock payments on publicly traded companies (Podolny and Feldman, 1997). In addition to the IPOs, venture capital firms also may profit if a firm

in which they have invested is acquired by another firm. "Investors in the [VC] funds typically profit when a start-up company is sold or issues public stocks. If the company fails, the money is gone." (*New York Times*, 1995, Jan. 28: p.32). The performance of a VC firm can thus be measured in terms of the frequency with which firms backed by the VC firm go public through an IPO or are acquired by another firm (Hsu, 2006).

Given the fact that many start-up companies fail before being acquired or going public through an IPO, the VC industry is overall a high risk industry in which high returns are expected but often not realized (Cochrane, 2005). A VC firm's investment decisions are full of uncertainties and ambiguities, and information plays a critical role in wise decision-making in this industry. While public and private equity markets have similar median returns, private equity returns (of which venture capital is a subset) are positively skewed (Griffiths, 2003). The high degree of outcome variability, consequently, makes information about the market vital to VC firms in order to make correct decisions about investments, and network connections serve as significant channels for diffusing such information (Podolny, 2001). One important source of information for VC firms is their network of syndicated investment partners. VC firms in the United States have a long tradition of cooperation through syndicated investments (Reiner, 1989). These investment syndicates, in earlier years, served to reduce financial risks, as the market was small, but they now also serve as channels for sharing information and other non-financial resources (Podolny, 2001; Sorenson and Stuart, 2001). Strong relationships tend to develop among syndicate members, since they must rely on each other and establish mutual trust (Sorenson and Stuart, 2001). Syndicate channels can provide referrals to new investments (Fried and Hisrich, 1994) and serve as channels to share knowledge (Bygrave and Timmons, 1992) and as tools to resolve informational uncertainties about potential investments (Lerner, 1994). It is therefore important to understand syndicated investments

from a network perspective in order to identify the implications of interactions among the firms involved.

In the current study, if two VC firms were involved in a syndicated investment, they were regarded as having network ties. Using detailed co-investment information, dyadic ties were used to construct assumed networks. These differed from a typical affiliation matrix in that directly connected firms did not necessarily have strong relationships with substantial information exchange.

An important question related to our theoretical framework is how we should understand the notion of absorptive capacity in the VC context. Absorptive capacity is a concept most often employed in the context of innovation or research and development (RandD) investment, with an assumption that firms doing more RandD ought to have greater absorptive capacity (Cohen and Levinthal, 1990). The absorptive capacity of VC firms might be reflected in their ability to screen, evaluate and assimilate external information to improve their performance. For instance, a VC firm might learn that other firms use certain legal terms in their deal-making contracts, and it would then need to decide whether or not to adopt the same practice (Suchman, 1995). Absorptive capacity is important to VC firms because how they digest external information is crucial to their decision-making and subsequent performance.

THEORY AND HYPOTHESES

Small-world Networks and VC Firm Performance

In a highly uncertain environment where decisions need to be made quickly, such as the venture capital (VC) market, fast access to diverse information is essential for firms to make sound decisions for their strategic moves (Podolny, 2001). Small-world networks, with locally clustered networks that have short path lengths connecting different clusters (Watts, 1999), can influence a firm's performance by influencing the direction and speed of the information flow among different actors in the networks. If a network is randomly formed (each member selects its partners regardless

of geographic, demographic or other considerations) its structure has a minimum average path length among the members (Bollobas, 1985). In real life, however, many links are highly clustered with overlapping relation-ships (e.g., a friend's friend is a friend). With a high degree of clustering, one would expect to see sparse links (long average path lengths). Research on small-world networks, however, has found that when a few links are added to a highly clustered network, the network's reach can be dramatically increased, leading to a small-world network with both a high level of clustering and short path lengths (Watts and Strogatz, 1998).

Dense local clustering normally works against short paths linking partners. That they coexist in small-world networks has prompted researchers to speculate that such networks may have strong and unique impacts on members' behaviors and outcomes (Feld, 1981; Newman, 2000). Empirical research on small-world networks has been carried out in contexts including German corporate ownership (Kogut and Walker, 2001), American corporate boards of directors (Davis et al., 2003) and Canadian investment bank syndicates (Baum et al., 2003). A few empirical studies have explored the performance consequences of small-world networks (Fleming et al., 2007; Schilling and Phelps, 2007; Uzzi and Spiro, 2005).

However, the empirical results from the research of the performance of members of small-world networks have been mixed (Uzzi, et al., 2007). For instance, Fleming et al. (2007) failed to find any statistically significant effect of a small-world network on regional inventors' innovation activities. In a study of Broadway artists, Uzzi and Spiro (2005) found that the relationship between their small-world networks and their creativity was curvilinear: the creativity of network members increased up to a threshold and then decreased. Schilling and Phelps (2007) revealed that firms experienced more knowledge creation when they were in networks characterized by both high clustering and short average path lengths. Extant research did not, however, give enough attention to organizational performance in terms other than innovation or creativity.

The current study was designed to investigate whether or not small-world networks affect firms' financial performance in a context that has not previously been considered. Given the specific context, networks of VC firms with high clustering and short average path lengths (a high degree of "reachability") might be expected to perform better than those without these properties. Prior empirical studies have found both linear and nonlinear relationships between network structure and performance with different ties and levels of analysis (Uzzi et al., 2007), but in the VC context, where uncertainty levels are very high and entries and exits of participants are very frequent, a small-world network is less likely to become a closed "one-world" network. This suggests that a linear correlation between network structure and performance is more likely in this particular context[1].

Given the dense local clustering and quick reach to other parties in a small-world network, belonging to such a network should give significant advantages to a VC firm in terms of being exposed to useful information and knowledge. Dense clustering should transfer information and other resources more efficiently (Etzkowitz, Kemelgor, and Uzzi, 2000; Reagans and McEvily, 2003). Reachability enables network members to gain novel information and ideas from distant sources (Burt, 2001; Schilling and Phelps, 2007), since weak ties or disconnected structural holes benefit the acquisition of unique information (Burt, 1992; Granovetter, 1973). In the example of legal terms particular to the VC market, VC firms in a small-world network should be able to learn the various usages of legal terms and the different effects of using them more quickly than would firms that are not members of small-world networks.

However, if some members of a network with dense local clustering are not connected to each other at all, the benefits of better information transmission through clustering might be offset by a high degree of information redundancy (Burt, 2001; Fleming et al., 2007). On the other hand, if actors are in a network that reaches distant information sources but in which there is no dense local

[1] We also empirically tested if the relationship is non-linear. As shown in the results, we did not find evidence to support a non-linear relationship between small-world networks and firm performance.

clustering, the benefits of gaining novel information and knowledge could be offset by relatively slow transmission. High clustering accompanied by a quick reach should provide a good mixture of information and transmission speed, maximizing performance benefits. Indeed, Cattani and Ferriani (2008) have shown that a balance between information transmission and the exposure to novel information provides the optimal information advantage. Such a balance also corresponds to the ambidexterity of exploration and exploitation (March, 1991), because a fully connected network structure encourages network members to exploit information, while a loosely connected structure encourages members to explore. In a simulation study, Lazer and Friendman (2007) showed that in solving complex problems, a network structure balancing exploration and exploitation will result in the best performance. Given the high level of uncertainty and fast changes in the VC market, it is critical for VC firms to have quick access to new and diverse information (Podolny, 2001). Since VC firms tend to cluster by industry and region (Saxenian, 1994; Sorenson and Stuart, 2001; Stuart and Sorenson, 2003), firms in a network with both dense local clustering and high reachability should be in a better position, leading to better investment decisions and consequently better performance. The key information for VC firms is of course about target firms suitable for investment and their prospects. A VC firm in a small-world network may sometimes be able to access unique information quickly through syndicated investment ties. This reasoning suggests that:

> **H1:** Venture capital firms in networks combining a high degree of clustering and short average path lengths to a wide range of firms (a higher level of small-world network connectivity) will perform better than will VC firms in networks that do not exhibit these characteristics.

Contingent Factors: A Firm's Absorptive Capacity

Small-world networks can be understood as part of the external competitive environment in which firms look for information and opportunities, compete for resources, and interact to generate returns. Such networks describe extensive connections among actors with particular impact on the

distribution of information and other resources that are helpful to firm performance. Although a small-world network can have an overall impact on the performance of all of its firms, different firms are likely to experience varied impacts depending on various factors.

Given that the benefits of small-world networks have largely to do with the diffusion of new information and knowledge, an important factor affecting their influence is how a firm recognizes the value of new external information and knowledge and then how it assimilates and applies the new learning. Firms that can recognize, assimilate, and apply new external information more efficiently and effectively can benefit more from their networks. A firm's capability to recognize, assimilate and apply new external information and knowledge has been termed its absorptive capacity (Cohen and Levinthal, 1990). The concept of absorptive capacity has been used in many different contexts, including the transfer of best practices within a firm (Szulanski, 1996), knowledge exchange in interfirm alliances (Lane and Lubatkin, 1998, Mowery, Oxley and Silverman, 1996) and the effectiveness of information technology systems (Boynton, Zmud and Jacobs, 1994). Cohen and Levinthal (1990) emphasized that the absorptive capacity concept can be discussed in the context of technological knowledge, but it can also be used in the context where the firm absorbs other information and knowledge related to the market and the general external environment. A VC firm absorbs, for example, new legal contract terms, new firm structures, and investment options in new industries or regions, as well as information about overall market conditions, general environmental conditions, and firm-specific knowledge. A VC firm with greater absorptive capacity is more likely to notice the importance of the information and knowledge coming its way and more effectively assimilate this information and knowledge, incorporating it into existing practices and routines and consequently improving its performance.

Prior research on absorptive capacity has focused on RandD and a firm's past experience as sources of absorptive capacity (Cohen and Levanthal, 1989, 1990). Since VC firms typically do not

have an RandD function, their ability to acquire, codify and apply external information and knowledge is largely dependent on their overall resources. Overall resources may thus be a valid proxy for a VC firm's absorptive capacity. Absorptive capacity has been shown to relate to prior experience (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998). Both accumulation of experience and diversity of experience were found to affect an organization's ability to learn from experience and transfer this learning into internal routines (Amburgey, Kelly and Barnett, 1993; Cohen and Levinthal, 1990; Haunschild and Sullivan, 2002). Therefore, accumulation of experience and diversity of experiences may largely determine a firm's absorptive capacity. Below, we specifically develop theoretical arguments about how a firm's overall resources, accumulated experience and diverse experiences influence the impact of small-world networks on firm performance.

A Firm's Overall Internal Resources and the Influences of Small-world Networks

It is now widely accepted that firms with valuable internal resources can have a competitive advantage in the market (Barney, 1991; Peteraf, 1993). Such resources can also influence a firm's behavior (Mahoney, 2005; Penrose, 1959). For instance, a firm can be more risk-taking and can look more actively for new opportunities when it has more resources, especially more slack resources (Cyert and March, 1963; Greve, 2003a, 2003b; March and Simon, 1958). Empirical research has found that firms with more slack resources are more able to create buffers against any potential damage associated with taking risky actions (Thompson, 1967) and thus are more likely to take risks than are those with fewer slack resources (Audia and Greve, 2006).

Research on absorptive capacity suggests that it is directly linked to a firm's resources. In a series of seminal studies on absorptive capacity and innovation, Cohen and Levanthal (1989, 1990, 1994) used a firm's RandD spending as an indicator of its absorptive capacity. Just as a firm's RandD resources can indicate its absorptive capacity in the context of technological innovation, so too can its overall resources, indicated by, for example, the number of employees or its financial

capital, to a large extent indicate a firm's overall absorptive capacity for evaluating, codifying, assimilating and applying new information in all aspects of its operations (Cohen and Levanthal, 1990).

More resources increase a firm's ability to search the external environment (Cyert and March, 1963), increasing the likelihood of encountering useful new information. A firm with more resources can also afford better screening to evaluate new information. For instance, such firms can dedicate more and better personnel to finding and analyzing market information. Second, resource-rich firms can allocate more resources to extracting and analyzing useful information and then transforming it so that it can be used by the firm. Finally, if new information is deemed valuable, a firm with more resources is better able to capitalize on it. In the VC context, for instance, if there is information indicating an emerging investment opportunity, compared to firms with limited financial resources, VC firms with more capital are in a much better position to exploit this opportunity without hampering existing investment options. The information advantage from their small-world networks can help VC firms make better judgments about investment choices, but VC firms with more overall resources have greater absorptive capacity and thus can be in a better position to evaluate and act on investment options, leading to better performance for those firms.

> **H2:** The positive relationship between small-world network connectivity and firm performance will be stronger when a VC firm has more resources.

A Firm's Prior Experience and the Influences of Small-world Networks

Another important factor that indicates a firm's absorptive capacity level is its prior experience, as the development of absorptive capacity is path dependant and bounded by particular cognition structures (Cohen and Levanthal, 1990). It has been well documented that firms can learn from experience (see Argote, 1999 for a review). Related to the development of absorptive capacity, a firm's past experience can affect where and how it searches for new information and knowledge

(Cyert and March, 1963) and also its ability to evaluate, assimilate and apply new information and knowledge (Zahra and George, 2002), and to develop new routines (Nelson and Winter, 1982).

Cumulative experience may thus be a useful proxy for absorptive capacity. Experience helps firms develop and use new routines and exploit information. The more cumulative experience a firm has the more absorptive capacity it can develop through learning from exposure to relevant knowledge (Kim, 1998; Zahra and George, 2002). This connection is exemplified by the production learning curve, where the unit cost of production decreases as organizations gain experience with a product (see Argote, 1999 for a review). In a study of bank performance, Barnett, Greve and Park (1994) found that specialist banks had higher returns on assets if they had more cumulative experience. Amburgey and Miner (1992) found that firms tend to make sequential acquisitions of similar firms because more experience with a particular type of firm enhances their skills and knowledge about this particular type of acquisition. Bergh and Lim (2008) found that cumulative experience with corporate sell-offs leads to subsequent sell-offs and better performance because of the competency related to sell-offs that develops. Cumulative experience also affects how knowledge is codified and translated into routines, rules, procedures and systems (Amburgey et al. 1993; March and Sevon, 1984)

VC firms with more cumulative experience with investments are more likely to develop skills and competencies to deal with issues related to investments. The more repeated experience of investments a firm has, the more likely that the firm has better understanding about the details of investment steps, formal or informal procedures, the external environment, and target firm characteristics that might match the interests of the VC firms. The absorptive capacity of the VC firms can be developed as a result, and knowledge from those experiences can be better incorporated into their existing routines. This development of absorptive capacity as a result of prior cumulative experience can help firms to understand the information from the small-world network

more efficiently because the firms can more quickly identify the usefulness of the information and ways to digest the information due to their past experience. Thus, we offer following hypothesis:

> **H3:** The positive relationship between small-world network connectivity and firm performance will be stronger when a VC firm has more cumulative experience.

A firm's prior diverse experience and knowledge can contribute to a firm's absorptive capacity for at least two reasons. First, organizational learning research has found that diverse experiences and information can help firms learn because experience pushes firms to do deep analyses and find better solutions. For instance, firms were found to learn better when they were confronted with heterogeneous learning experiences from their network partners on acquisition premiums (Beckman and Haunschild, 2002). Research studies have also found that diverse experience helps firms define better diversification strategies (Barkema and Vermeulen, 1998). Haunschild and Sullivan (2002) found that US airlines had fewer accidents when they had more heterogeneous error experiences. In the context of the VC market, an important source of a firm's diverse experience is from a firm's diverse investments in different industries. Within a small-world network, a high degree of cohesion can facilitate the coordination and synergy of those diverse experiences, enabling firms to learn better. This better learning can help firms acquire not only more resources as a result of improved performance, but also increased capability to evaluate, assimilate and apply external information and knowledge.

Second, diverse experiences contribute to absorptive capacity not only because they enhance the knowledge pool and skills for the firm but they also help a firm to develop routines to evaluate, understand, and utilize diverse external information (Cohen and Levinthal, 1990). If a VC firm has a high degree of experience in making diverse investments of different nature (e.g., in different industries), it is likely that the firm will develop particular routines and practices to deal with complex and diverse information flows. Therefore, the information and knowledge that the VC

firms learn from prior diverse investments will also increase their capacity to process subsequent diversified information and knowledge regardless of the sources of this information and knowledge.

Enhanced absorptive capacity from diverse experience has particular importance for our study context, given the nature of small-world networks. A firm's prior experience with new external information and knowledge is crucial in building its ability to recognize, absorb and apply the information and knowledge generated from the small-world network. Further, the information and knowledge from the small-world networks can be categorized by its richness, which to an extent implies the complexity of the information residing in the networks and perceived by the focal firm. Since diverse experience comes with inherent information and knowledge complexity (Haunschild and Sullivan, 2002), a focal firm's prior experience with diverse information and knowledge flow can also be of particular help to the focal firm in dealing with the flow of complex information and knowledge from small-world networks.

Therefore, a VC firm's diverse experience in investments can to a large extent indicate a firm's absorptive capacity, especially in our research context, consequently leading to more effective evaluation, assimilation and application of information and knowledge from small-world networks. Thus, we posit the following hypothesis:

> **H4:** The positive relationship between small-world network connectivity and firm performance will be stronger when a VC firm has more diverse experience.

METHOD

Sample and Data

Our dataset consists of U.S. venture capital (VC) firms that made investments during the period from 1995 to 2003. Information about co-investment from 1990 to 1994 was also used to generate network variables. The data were collected from the SDC Venture Economics and MandA databases, which recorded investments of venture capital firms since the early 1970s and MandA

transactions since 1979, respectively (Podolny, 2001; Sorenson and Stuart, 2001). The study period was selected because VC industries became more prominent in the 1990s and there were significant ebbs and flows during that period (De Clercq et al., 2006). Data from SDC are also reliable and comprehensive from that time period.

Since we maintain that the impact of the small-world networks starts from the screening of investment opportunities, in our analysis, we track the performance of each investment from the investment date to the time when a target firm went public through an IPO or was acquired. As VC firms might participate in different investment rounds in the same target firm, and each round could be a different investment stage, we further organized our data at the round level for a particular target firm. If a round leads to an IPO or acquisition, we treat it as one event, coded as "1". If a round did not lead to an IPO or acquisition, and the target firm was still in existence in 2003, it was treated as right censored. If a target firm went bankrupt during the study period, we coded the event as "0". We updated the information about covariates yearly. After deleting the observations with a large portion of missing values, the final sample included a total of 38,416 investment firm-round-year observations for 1,287 VC firms.

Dependent Variable

The dependent variable was the hazard rate (Elandt-Johnson and Johnson, 1999) of going public through an IPO or being acquired for an investment from the focal VC firm. An investment round entered into a risk set for estimation of the hazard rate at the time when it received investment from the focal VC firm and exited the risk set when the target firm went public or was acquired.

Independent Variable

Applying insights from prior research (Podolny, 2001; Sorenson and Stuart, 2001), joint (syndicated) investments among the VC firms were used to construct network variables. To generate

the network variables, we constructed an adjacency matrix representing the network ties (joint investments) between VC firms. We coded the matrix with a "1" indicating that two firms were tied through joint investment in one particular investment round and a "0" indicating that they were not. Following Sorenson and Stuart (2001), we considered all co-investments in a five-year time window, assuming that such a relationship will erode over time. If two VC firms had not co-invested in the previous five years, it is unlikely that they remained close confidants (Sorenson and Stuart, 2001). By collecting the network variables with this prior time window, we also avoided the possible reverse causality problem.

S*mall-world connectivity* was calculated for different industries because VC firms tend to focus on particular industries (Kogut, Urso and Walker, 2007; Sorenson and Stuart, 2001) and information that flows among VC firms with the same industry focus is especially important to VC firms' performance. Industry was also used as the boundary to define the small-world networks in prior research (Schilling and Phelps, 2007). In our particular context, a VC firm's industry category is defined by the industry of each investment round a VC firm invested in reflecting the knowledge and expertise a VC firm might have for a particular industry.

We constructed our small-world networks in different specialized industries by the VC firms in a particular year, with ten industry categories identified by the SDC database. We therefore had a total of ninety small-world networks (10 industries by 9 years) in our sample for the study period. The descriptive statistics of small-world networks for the ten industrial categories are provided in Table 1, where network size describes the total number of VC firms in a network.

--------Insert Table 1 about here-------

Following the convention in the research literature on small-world networks (e.g., Kogut and Walker, 2001; Verspagen and Duysters, 2004), we considered two components of a small-world network: the clustering coefficient (CC) and the reachability (Reach), with the former representing

the degree of local clustering and the latter indicating the degree of path length among actors (a higher reachability implies a shorter path length).

We used a weighted overall clustering coefficient (Borgatti, Everett, and Freeman, 2002, Newman, Strogatz and Watts, 2002) to measure the clustering coefficient. This measure indicates the transitive closure of a graph and is defined as:

$$\text{CC}=\frac{3\times(\text{number of triangles in the graph})}{(\text{number of connected triples})},$$

where a triangle is a set of three nodes, each of which is connected to the other two, and a connected triple is a set of three nodes in which at least one is connected to both of the others. This indicator is from 0 to 1, with "0" indicating no clustering and "1" indicating full network clustering. We computed the clustering coefficient by applying the "clustering coefficient" procedure available in the software package UCINET VI (Borgatti et al., 2002).

To measure the component of reachability for a small-world network, we used the average distance-weighted reachability to capture the degree of global separation in a given time period (Borgatti et al., 2002; Borgatti, 2006). This compounded measure takes into account both the number of firms that can be reached by any path from a given firm, and the path length that a given firm follows to reach all other firms. For each actor's distance-weighted reachability (DWR), the measure is calculated as follows:

$$DWR=\left[\sum 1/d_{ij}\right]/n,$$

where n is the number of nodes a focal actor can potentially connect to in the network and d_{ij} is the minimum geodesic distance from a focal actor, i, to a partner, j($i \neq j$). This indicator ranges from 0 to 1, with larger values indicating a high degree of distance-based reachability. Then we took the average of DWR across all the firms in the network to measure the reachability.

Some previous studies have used the inverse of path length to measure the component of reachability (Fleming et al., 2007; Uzzi and Spiro, 2005), but the average distance-weighted reachability has two important benefits in our context. First, the average distance-weighted reachability can "… avoid the infinite path length problem associated with disconnected networks by measuring only the path length between connected pairs of nodes and it provides a more meaningful measure than the simple average path length between connected pairs by factoring in the size of connected components" (Schilling and Phelps, 2007: 21). Second, this measure accounts for the size of the network for different actors. Because the networks in our sample are very different in size for each firm (please refer to Table 1 for more detailed information), using distance-weighted reachability becomes necessary. We computed the reachability using UCINET VI (Borgatti et al., 2002).

Small-world connectivity was then measured by the interaction between the clustering coefficient and reachability: CC × Reach (Schilling and Phelps, 2007; Uzzi and Spiro, 2005), after centering the clustering and reachability variables to facilitate interpretation of their effects (Fleming et al., 2007; Friedrich, 1982).

Moderating Variables

The current study examined three potential indicators of firm absorptive capacity moderating the relationship between small-world networks and VC firm performance: firm resources, firm cumulative experience, and firm experience heterogeneity.

Firm resources were measured by two variables: firm size and cumulative prior performance. Firm size has been utilized as an indicator of a firm's current resource endowment (Audia and Greve, 2006). Mitchell (1994: 577), for instance, suggested that "larger businesses tend to have larger pools of financial and managerial resources." Also, a firm with larger size may increase the potential to attract additional resources (Brüderl and Schüssler, 1990). Firm size was measured by the total

number of investment rounds in which a VC firm participated in a particular year. Another indicator of firm resource was a VC firm's cumulative prior performance, because better performance usually helps a firm accumulate more financial, intellectual and material reserves (Villalonga, 2004). This variable was measured by the cumulated number of entrepreneurial firms going public through IPO or being acquired that the focal VC firm has ever invested in up to the current year.

Firm cumulative experience was measured by the cumulative number of prior investment rounds previously conducted by a VC firm. *Firm experience heterogeneity* was measured by an entropy-based diversity indicator (Ancona and Caldwell, 1992): $-\sum p_i \ln p_i$, where p_i was the proportion of the cumulative number of prior investment rounds in industry i among all the cumulative number of total prior investment rounds. The greater the entropy score, the more heterogeneous the firm's experiences.

Control Variables

To rule out alternative explanations, investment round, firm, and network control variables were included in the analysis. At the round level, we controlled for the investment value of each round, since rounds with different investment amounts may display different impetus for development (Hsu, 2006); the investment order for each round was also included to control for the fact that later rounds with more experience provide better performance outcome; we also controlled for the investment stage of each round, since different investment stages may imply different potential for the start-up companies to go public through IPOs or get acquired (Podolny, 2001). We also included a set of industry dummies (10 categories with one omitted category as the reference group) to control for any additional industry-level effect in firm performance.

At the firm level, we controlled for firm age since firms of different ages exhibit different tendencies to make strategic choices (Hannan and Freeman, 1987) and could affect a firm's perform-ance. Since the more central the firm is in the network, the more likely it will acquire more

and diverse information useful to decision making (Davis, 1991; Haunschild and Beckman, 1998), a firm's closeness in the network was also controlled, measured by a firm's average distance to other members of the network (Freeman, 1979) and was calculated with the following equation: $C_j = (n\text{-}1)/[\sum_i d(i,j)]$, where $d(i,j)$ is the path distance between firms i and j. A firm's structural holes can also affect its opportunity to gather and integrate more and diverse information (Burt, 2004), so a structural hole measure for each firm was also controlled as measured by the following formula: $1\text{-}(r_{ij} + \sum_q r_{iq} r_{qj})^2$, where r_{ij} is the proportion of i's relations invested in actor j, and the total in parentheses is the proportion of i's relations that are directly or indirectly (through another node, q) invested in the connection with contact j. We used UCINET VI (Borgatti et al., 2002) to calculate the closeness and structural holes based on the co-investment ties among VC firms for each year.

At the network level, we controlled for the overall density of each industry, measured by the ratio of existing links in one particular industry to the number of possible pair-wise combinations of firms in that industry because the rate and extent to which information diffuses should increase with density (Yamaguchi, 1994). UCINET VI (Borgatti et al., 2002) was again used to calculate the net-work density for each industry for each year.

Models

To model the hazard rate of going public through IPOs or being acquired, we used the piecewise-constant exponential event history model (Blossfeld and Rohwer, 2002) since the hazard rate is likely to be constant in certain time intervals given the distinctive pattern of VC industry development over the years. This model is formally specified as the following:

$$\ln h_i(t) = \alpha_p + \boldsymbol{\beta}' \mathbf{x}_{it}, \quad p = 1, \ldots, P,$$

where $h_i(t)$ is the hazard rate; $\boldsymbol{\beta}'\mathbf{x}_{it}$ is a vector of coefficients ($\boldsymbol{\beta}$) and covariates ($\mathbf{x}$); and α is a constant that is allowed to vary between pre-selected periods, p. Corresponding to the trend in the VC industry, we used the following three periods: 1995-1998, 1999-2000, and 2001-2003. We estimated the models using the "stpiece" command in the statistical software package, STATA (Sørensen, 1999). Since one VC firm may invest in multiple rounds in one particular year, we corrected for this effect by clustering data on the same firm (Rogers, 1993).

RESULTS

Table 2 presents descriptive statistics and correlations for the study variables. The table shows that the correlations among the variables were not particularly high. A further inspection of the correlations among the independent variables did not reveal any serious multicollinearity, showing a mean variance inflation factor (VIF) of 2.44 and a maximum VIF of 6.44, which is lower than the critical threshold value of 10 (Kennedy, 1998). To avoid possible collinearity among the interaction terms, the variables involved in the interaction terms were mean centered by subtracting the mean from each value (Aiken and West, 1991). As there are multiple three-way and two-way interaction terms, to further avoid collinearity problems, we input the interaction terms of different variables with small world networks separately in each model.

--------Insert Table 2 about here-------

Table 3 presents the results of piecewise-constant exponential model estimates of the impact of small-world networks on VC firm performance. Model 1, as a baseline model, including our independent variable and all the control and moderating variables, tests the main effect of the key independent variable, small-world network connectivity. Both clustering and reach are found to be positively and significantly related to VC firms' performance ($p < .001$). The coefficient of the small-world connectivity (the interaction of clustering and reach) is positive and significant ($p < .001$). This

result supports Hypothesis 1, which suggests that small-world networks positively influence firm performance. This relationship was consistent across all the models.

The effects of the control and moderating variables were generally consistent across the different models, and they are interpreted based on the results from Model 1. At the investment round level, the greater the values of an investment round, the more likely that the investment resulted in an IPO or acquisition ($p < .001$). This result is consistent to the findings of Hsu (2006). Consistent with prior arguments (e.g., Podolny, 2001), the later the stage of the round, the more likely it was that the start-up company would go public through an IPO or get acquired ($p < .01$). Investment order was found to have a negative and significant impact on VC performance ($p < .001$); the more investors participate in one particular investment, the more likely the start-up company would subsequently go public through an IPO or get acquired ($p < .001$). At the VC firm level, a VC firm's age had a positive and significant effect on firm performance ($p < .05$). At the syndicated network level, network density was found to be positively related to firm performance ($p < .001$). Among the moderators, a firm's size was negatively related to its performance ($p < .05$), and a firm's cumulative prior performance was positively related to its performance ($p < .001$).

--------Insert Table 3 about here-------

Prior research has found that small-world networks display a curvilinear effect on actors' outcomes in some situations (Uzzi et al., 2007; Uzzi and Spiro, 2005). To test this possibility, Model 2 included the square term of small-world connectivity. The small-world connectivity term was positively significant, but its square term was not significant, suggesting that the small-world networks do not show a curvilinear relationship in our context. Schilling and Phelps (2007) have argued that when maintaining interpersonal relations is important, a curvilinear effect is more likely (Uzzi and Spiro, 2005); when interpersonal cohesion is less important for collaboration, then a linear relationship is more appropriate. For our study context, interpersonal cohesion is less likely to play

an important role in cooperation among the venture capital firms. This may explain the linear effect found in the current study.

Models 3 to 6 were used to test Hypotheses 2 to 4. The predicted effects were tested in the order of the hypotheses. Model 3 tested the interaction effect between small-world networks and firm size. The empirical results supported Hypothesis 2, suggesting that firm size will strengthen the relationship between small-world networks and firm performance: the coefficient of the interaction term was positive and significant ($p < .001$). Model 4 tested the interaction between small-world networks and the firm's cumulative prior performance. The results again supported Hypothesis 2, suggesting that firm cumulative prior performance strengthens the relationship between small-world networks and firm performance: the coefficient of the interaction term was positive and significant ($p < .05$). Model 5 tested the interaction of small-world networks and the firm's cumulative experiences. The interaction coefficient was positive but not statistically significant. Hypothesis 3 was thus not supported by the results from the current study. Model 6 tested the interaction of small-world networks and firm experience heterogeneity and as predicted by Hypothesis 4. The interaction was positive and significant ($p < .01$), indicating that diverse experience will strengthen the positive relationship between small-world networks and firm performance.

To facilitate the interpretation of the interaction effects, we plotted the effect of small-world network connectivity on firm performance based on either the higher or the lower level of firm size, cumulative prior performance, and experience heterogeneity. Figures 2-4 show that when the three moderators are at a high level (half a standard deviation above the mean for firm size and cumulative prior performance, and one standard deviation above the mean for experience heterogeneity), the slopes indicating the relationship between small-world network connectivity and VC firm performance tend to be much steeper.

--------Insert Figures 2-4 about here-------

DISCUSSION AND CONCLUSION

The current study confirmed that small-world networks have a statistically significant impact on the performance of firms in the venture capital industry. We further found that the positive relationship between small-world networks and VC firm performance is moderated by the VC firm's absorptive capacity as indicated by a firm's overall resources and its diverse experiences.

The empirical results from our study confirm our contention that firms can gain different benefits from small-world networks, depending on their capability to recognize, absorb and apply external information and knowledge. Our study contributes to the extant research literature on small-world networks by showing the impact of small-world networks in a different setting with different organizational outcomes and revealing potential contingent factors that can affect the influences of small-world networks. We highlight that a firm's ability to absorb external information and knowledge is important in understanding the impact of small-world networks on firm performance. Overall, the current study has helped delineate the boundary conditions that can shape the influences of network structures.

One surprising result from this study is that we failed to find that a firm's cumulative experiences moderate the relationship between small-world networks and performance. As prior cumulative experience tends to generate redundant knowledge and information that enable firms to refine existing routines (Argote, 1999), a firm's capabilities built through cumulative experience may not help it to absorb and utilize information from small-world networks rooted in an uncertain and dynamic environment such as the VC industry.

Implications

One implication of these conclusions is that it is important to understand the interactive nature of small-world networks and individual firms that possess different capacities and compete for and acquire resources from external environments. While firms normally operate in a relational

web that is not totally in their control, their searches, interactions, and preferences can affect how they utilize the global network where they participate as a member, consequently affecting their performance.

Second, our study suggests the possibility that the extensive information and knowledge available to a firm does not necessarily mean that a firm can always use that information and knowledge effectively. It is likely that a firm can absorb the information and knowledge only when it has sufficient capabilities, and that a firm can effectively use information and knowledge only when it develops its ability to recognize and absorb highly diversified and complex information and knowledge.

The present study also has certain managerial implications. First, our study suggests that it is critical for managers to understand the network "environment" where their businesses are embedded. Prior research on social networks has provided meaningful guidance for managers to benefit from the focal firm's local networks, such as building networks with more structural holes (Burt, 1992, 2004) or with high network status (Jensen, 2003; Podolny, 2001). Our findings suggest that mangers should give more attention to the small-world network environment, because it directly affects the strategies a firm could use to effectively utilize the information from the network so that the firm's performance can be improved. Second, it is also helpful for managers to realize the importance of developing internal resources and capabilities in terms of enhancing the positive impact of a small-world network. Only when equipped with necessary and sufficient resources and capabilities can firms fully utilize the benefits generated from the small-world network and consequently improve the firm's performance.

Limitations

Because of the peculiarities of the VC industry, there might be a concern about generalizability. The VC market is extremely uncertain, fast-paced and full of risks in which decisions

need to be made quickly (Podolny, 2001). The need for quick access to quality information might be much larger in this industry than in other industries. However, given the fact that we have confirmed that there is a relationship between small-world networks in the VC industry and performance as suggested by other empirical research, we have confidence that our findings are robust. Future studies should look at the influences of small-world networks and the interactions of resources and experiences and global networks in industries where the information need is not as urgent. In that kind of industry, we might expect that the demand for sufficient resources and experience to acquire information might be not as strong as in the VC industry, and, consequently, the importance of the moderating variables might be weaker.

Second, we only examined small-world networks as defined by industry. Since prior research has shown that spatial proximity can facilitate or hinder the flow of information (McKendrick, Doner and Haggard, 2000; Stuart and Sorenson, 2003), it might also be meaningful to examine the small-world network phenomenon based on geography. The primary reason for us not to use geographic boundaries to construct small-world networks is that most of the VC firms in our sample are located in only a few regions, such as Palo Alto and Boston. As a result, we were not able to generate enough observations and variations among small-world networks to make meaningful estimates of our models. Future research studies might consider the roles of small-world networks in different regions.

Future studies

Future studies may be improved by an examination of the dynamics of small-world networks as a result of a firm's networking activities. A small-world network may change and evolve with the actions undertaken by the firms in the networks. Under certain circumstances, firms can break ties with others and create new disconnected relationships, leading to opportunities for some firms to be the brokers in the networks and also to change the platform of the small-world network. When ties

are broken, then the degree of the small-world connectivity will be decreased. On the other hand, it is possible that if many firms in an industry actively look for exchange partners, this particular industry can quickly become a well-connected, not-so-small-world network, and the benefits of the small-world network can be quickly dissolved.

Future research can also look at how some resources and capabilities can be conducive to firm performance in a small-world network environment, while others might be barriers. For instance, if a firm has a strong ability to learn from its own experience, then the information in the relational environment may not help the firm's performance and diverse information from the relational environment may hurt the firm's performance.

Third, future research studies can also examine if small-world networks can shape the impact of local network structures as well. Network studies have shown that both structural holes and network status have positive impact on firm performance (Burt, 1992; Podolny, 1993), with the former generating information benefits and the latter signaling benefits. With bounded rationality, a firm cannot process complete information from the environment (Cyert and March, 1963). While diverse information is likely to give firms more unique information about the market, excessively diverse information can also burden the firms in processing information. In a way, a small-world network with a relatively cohesive structure might impede firms with extensive structural holes to focus on certain information and to have a deep understanding of the diverse information channeling through the network ties. On the other hand, the information from a small-world network may not be so useful to a firm with high status, simply because of its attraction to others and because firms with high status can easily find good clients or promising firms for investment as in our VC market context.

In addition to the firm-level contingent factors considered in this study, future research might fruitfully examine factors at the individual, group, or industry level, and in particular, how

egocentric network variables may interplay with global network characters, such as small-world network connectivity (Brass, Galaskiewicz, Greve and Tsai, 2004). By doing so, we could extend our understanding of the antecedents and consequences of interfirm networks (Rowley and Baum, 2008).

Conclusion

This study provides empirical evidence on how small-world networks affect firm performance through the influences of a firm's absorptive capacity. It shows that a firm's strong absorptive capacity can facilitate the transmission of new information and knowledge from the small-world networks. Firms with a strong absorptive capacity can better screen, evaluate and assimilate information and knowledge residing in networks. Consequently, the positive impact of small-world networks on firm performance can be more evident for firms with a strong absorptive capacity. Given the important role of firm networks in firm performance, future research studies need to further explore the influences of global networks on firm performance as well as the contingent role of internal characteristics that enable a firm absorb the information from such networks.

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TABLE 1

The Distribution of Observations of VC Firms in Different Industries (1995-2003)

Industry Category [a]	Mean Network Size [b]	S.D. of Network Size
Biotechnology	109.89	26.17
Communications and Media	221.67	83.57
Computer Hardware	87.44	32.93
Computer Software and Services	308.44	126.52
Consumer Related	66.44	31.24
Industrial/Energy	40.22	9.24
Internet Specific	318.89	212.96
Medical/Health	177.67	37.07
Other Products	80	38.39
Semiconductors/Other Electronics	134.56	60.72

[a] For each industrial category, there was a network for each year from 1995 to 2003, thus a total of 9 networks for each industry.

[b] Network size was measured by the total number of syndicated VC firms in a network.

TABLE 2

Descriptive Statistics and Correlation Matrix of Study Variables [a]

Variables	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8
1. Event of Firm Performance	0.08	0.28	0	1								
2. Round Value	8.70	1.48	0	14	.05							
3. Round Stage	1.78	0.66	1	3	.06	.21						
4. Investment Order	161.94	210.39	1	1477	-.03	.14	.05					
5. Number of Round Investors	4.70	3.48	1	33	.10	.56	.27	.10				
6 .Firm Age	13.27	12.97	1	100	.02	.07	.04	.52	.06			
7. Firm Closeness Centrality	2.93	1.13	0.1	6.27	.17	-.14	-.03	.00	-.04	.04		
8. Structural Hole	0.63	0.26	0	0.95	-.04	-.22	-.03	-.32	-.20	-.17	-.05	
9. Density	0.04	0.02	0.02	0.21	.21	-.14	-.02	-.05	-.01	.02	.43	.01
10. Firm Size	33.50	37.31	1	220	-.01	.15	-.01	.74	.11	.51	-.05	-.34
11. Firm Cumulative Prior Performance	1.63	2.71	0	15	.11	.11	-.01	.45	.07	.28	.18	-.36
12. Firm Cumulative Experience	3.75	2.13	-2.3	7.27	-.00	.10	.08	.67	.11	.50	.06	-.48
13. Firm Experience Heterogeneity	1.26	0.49	0	2.22	.05	.01	.01	.45	.02	.37	.07	-.49
14. Clustering	0.37	0.17	0.19	1	.03	-.19	.05	-.03	-.15	.02	.13	.21
15. Reach	0.22	0.08	0.02	0.34	.06	.15	-.06	.00	.15	-.03	.10	-.22

	9	10	11	12	13	14
10. Firm Size	-.07					
11. Firm Cumulated Prior Performance	.10	.59				
12. Firm Cumulated Experience	-.01	.57	.41			
13. Firm Experience Heterogeneity	.07	.46	.34	.60		
14. Clustering	.25	-.15	-.13	-.03	.02	
15. Reach	.10	.13	.19	.02	-.01	-.85

[a] Correlation coefficients with a magnitude greater than .01 are significant at the 5% confidence level.

TABLE 3
Piecewise-Constant Hazard Rate Estimates of VC Firm Performance [a]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
1995≤Year≤1998	-13.814***	-13.759***	-13.917***	-14.066***	-13.854***	-14.485***
	(.855)	(.954)	(.859)	(.889)	(.860)	(.892)
1999≤Year≤2000	-14.791***	-14.735***	-14.892***	-15.044***	-14.831***	-15.465***
	(.878)	(.974)	(.882)	(.913)	(.882)	(.914)
2001≤Year≤2003	-15.889***	-15.833***	-15.987***	-16.142***	-15.928***	-16.557***
	(.901)	(.995)	(.906)	(.935)	(.907)	(.933)
Round Value	.246***	.245***	.245***	.246***	.246***	.246***
	(.032)	(.032)	(.032)	(.032)	(.032)	(.032)
Round Stage	.156**	.157**	.159**	.163***	.157**	.161***
	(.046)	(.046)	(.046)	(.047)	(.046)	(.046)
Round Investment Order	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***
	(.0003)	(.0003)	(.0004)	(.0003)	(.0003)	(.0003)
Number of Round Investors	.071***	.071***	.071***	.071***	.071***	.072***
	(.012)	(.011)	(.012)	(.011)	(.012)	(.012)
Firm Age	.007*	.007*	.008*	.007*	.007*	.007*
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Centrality	-.016	-.015	-.016	-.015	-.016	-.023
	(.032)	(.034)	(.032)	(.032)	(.032)	(.033)
Structural Hole Positioning	.023	.023	.015	.025	.021	.032
	(.204)	(.204)	(.204)	(.205)	(.204)	(.201)
Network Density	16.370***	16.345***	16.200***	15.608***	16.354***	15.801***
	(2.483)	(2.492)	(2.524)	(2.525)	(2.483)	(2.500)
Firm Size	-.005*	-.005*	-.0005	-.005	-.005*	-.005*
	(.002)	(.002)	(.003)	(.002)	(.002)	(.002)
Firm Prior Cumulative Performance	.092***	.092***	.088***	.107***	.092***	.090***
	(.020)	(.021)	(.019)	(.022)	(.020)	(.020)
Firm Cumulative Experience	-.021	-.021	-.018	-.019	-.014	-.019
	(.025)	(.026)	(.026)	(.026)	(.028)	(.026)
Firm Experience Heterogeneity	.181	.181	.148	.169	.181	.400**
	(.111)	(.111)	(.113)	(.112)	(.111)	(.121)
Clustering	11.024***	10.938***	11.198***	11.223***	11.040***	11.480***
	(1.112)	(1.261)	(1.141)	(1.135)	(1.113)	(1.128)
Reach	5.412***	5.331**	5.363***	6.151***	5.427***	6.430***
	(1.537)	(1.676)	(1.506)	(1.630)	(1.529)	(1.561)
Small-world Connectivity (SWC)	40.528***	41.620***	42.702***	41.471***	40.693***	41.276***
	(4.416)	(6.327)	(4.719)	(4.529)	(4.460)	(4.665)
(Small-world Connectivity)^2		17.392				
		(80.137)				
SWC × Firm Size			.311***			
			(.081)			
SWC × Firm Prior Cumulative Performance				1.711*		
				(.852)		
SWC × Firm Cumulative Experience					.679	
					(1.070)	
SWC × Firm Experience Heterogeneity						11.660**
						(4.536)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Wald's Chi^2	13928.54***	13991.71***	14398.73***	14635.50***	14177.42***	13758.34***
N	38416	38416	38416	38416	38416	38416

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, two-tailed test

[a] Since the interactions with small-world connectivity represent three-way interactions in nature, all other two-way interactions (e.g., clustering × size, reach × size, etc.) were controlled for in the models.

FIGURE 1
The Trends in the VC Market in the U.S. from 1995 to 2003

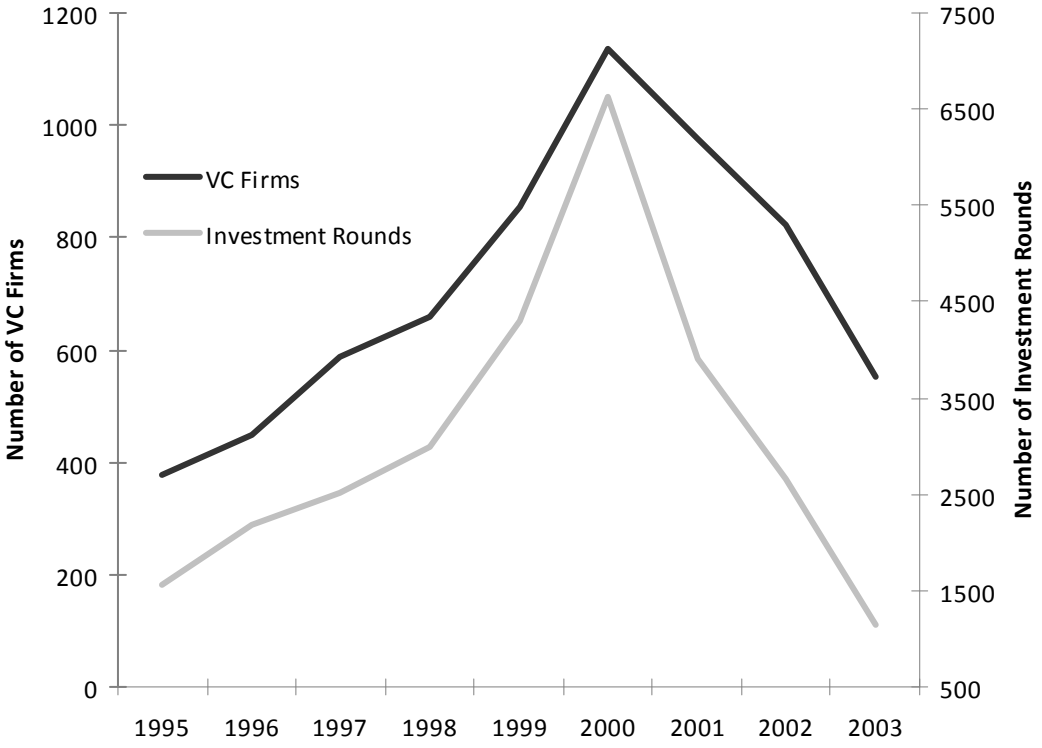

Figure 2
Interaction of Small-world Networks and Firm Size

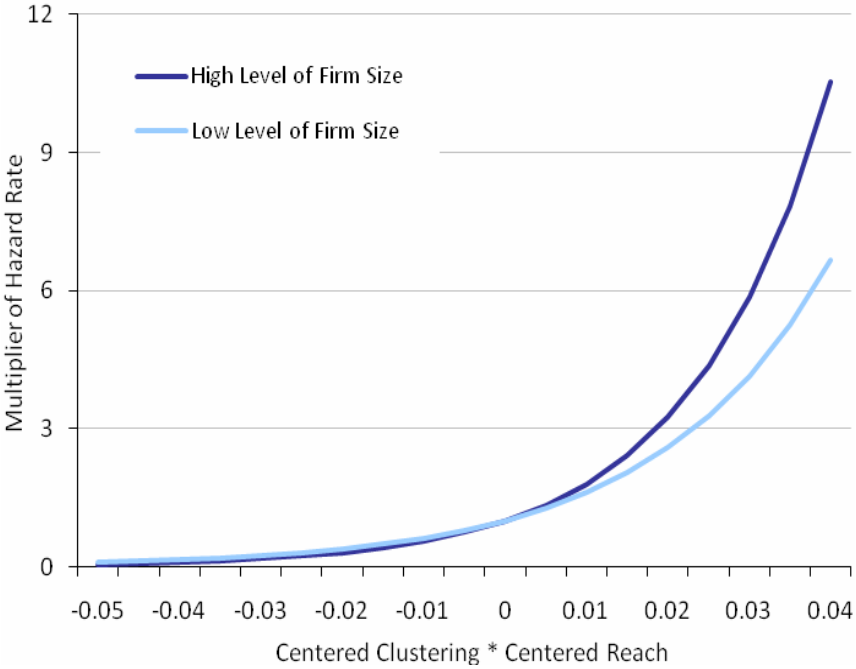

FIGURE 3
Interaction of Small-world Networks and Firm Experience Heterogeneity

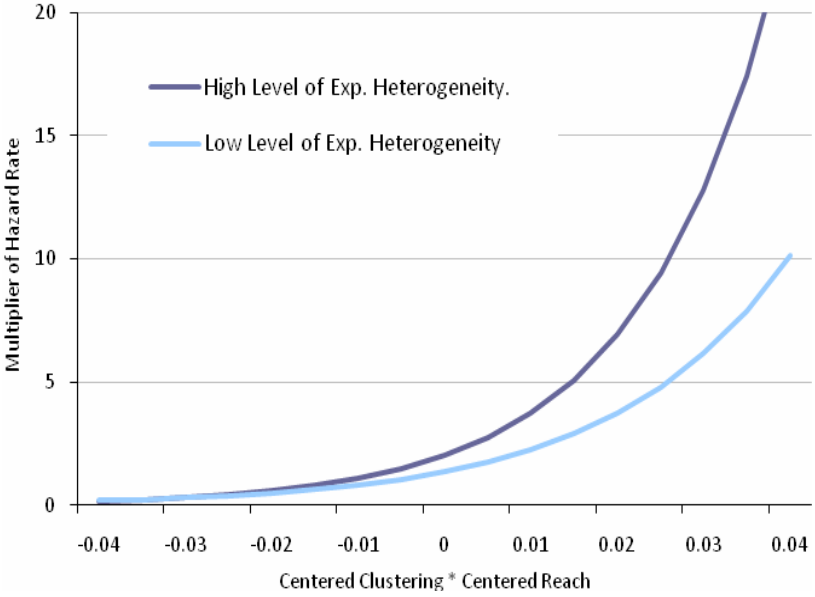

FIGURE 4
Interaction of Small-world Networks and Firm Prior Cumulated Performance