Mechanisms of Venture Capital Co-Investment Networks: Evolution and Performance Implications

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Students of high technology industry routinely acknowledge that communities knit together by networks of social relations are essential for the development of the industry (Saxenian 1994; Bernasconi et al. 2005) and emphasize that venture capitalists hold central positions in these networks (Banatao and Fong 2000; Castilla et al. 2000). Regis McKenna, a highly reputed IT industry expert, called the venture capital (VC) 'catalyst for [industrial social] networks' (Kenney and Florida 2000: 101). Other experts have compared the job of venture capitalists in high technology to that of coaches in professional sports (Hellmann 2000). These metaphors reflect the intuition that the role of VC in the development of high technology goes far beyond that of a mere provider of funds. More importantly, venture capitalists integrate the technological community and manage its human resources. Thus, understanding the consequences of their activity is essential to explaining the organization and the performance of the industry.

Yet the venture capitalists are not autonomous actors and themselves crucially depend on resources conveyed through peer networks. The majority of significant venture investment projects are managed collectively by several VC firms. Therefore, we can hardly obtain valuable insights into the role of VC in the development of the industry or single companies unless we extend the analysis to account for relationship-level and network-level processes. Researchers' recent acknowledgement of this requirement led to notable advancement of our knowledge on the functioning of venture capital networks. For example, Podolny (2001) argued that networks serve to reduce market uncertainty by conveying information and signals of actor's social status.

Sorenson and Stuart (2001) demonstrated that distance-spanning social networks help venture capitalists sort into new geographically remote markets.

We are, however, still left with a patchy picture. Most importantly, we lack the overview of the evolution of these networks over time and of the relationship between the functioning of the networks and the performance of organizations in the high technology industry. This study contributes to filling this gap. Relying on the literature, I distinguish four mechanisms through which venture capitalists' syndication networks (or, synonymously, co-investment networks) may affect investment recipients' performance. Next I construct operational measures of those mechanisms and describe the evolution of the whole VC co-investment network in the United States in terms of these measures. Finally, the effect of these indicators on the performance of investment recipient companies is examined. Thus, this work has a methodological, a descriptive, and an explanatory aspect.

The Venture Capital Industry and Its Syndication Networks

The Scope of VC Involvement in High Technology

The venture capital did not emerge as a distinct industry until the early 1970s, yet just a decade later it was already playing a vital role in nurturing technical innovation in the United States. By the end of 2000, venture-backed technology companies that had gone public accounted for over 20 percent of the total number of public companies in existence in the U.S. and 32 percent of the total market value of all public companies in the country (Gompers and

Lerner 2001: 67). The impact of venture capital was especially strong in Silicon Valley, which is the world's leading venture capital center.

Monetary support of a growing company is just one of the various ways in which venture capitalists contribute its development. Venture capitalists have a decisive say in the formation of a startup company's leadership team. They continue to exert their influence in the hiring and governance process until the funded company is sold or goes public, so it is not uncommon that a CEO or another high executive of a company funded by venture capitalists gets replaced on their demand. Typically a VC firm representative holds at least one seat on the board of directors of the funded company. As one venture capitalist put it, 'the average duration of a relationship between a venture capitalist and the entrepreneur is probably longer than the average duration of a marriage in California, and rarely less intense' (quoted in Hellmann 2000: 280). The performance of venture capitalists is wholly determined by the performance of the companies which they have helped to build, just the way the performance of coaches is judged by the results of the athletes they train. This is one reason why the coaches metaphor seems so apt when applied to venture capitalists.

Mechanisms of Co-Investment Networks

Lasting personal relationships (or embeddedness) and trust are probably the most often mentioned positive by-products of economic interaction (Woolthuis et al. 2005). Mark Granovetter's early statement of the importance of trust and embeddedness in economic relations (1985) was formulated as a critique of Oliver Williamson's *Markets and Hierarchies* research program. Williamson (1975) had pointed out that actors in modern markets are out for their own

interest and argued that taking advantage of other actors is often the best way to achieve their goals. Williamson's theoretical scheme did not see an efficient way of preventing the use of force and fraud by market participants except vertical integration, i.e. channeling market transactions into multi-divisional corporations and other hierarchical structures. He regarded vertical integration and mechanisms of corporate control as the remedy against ubiquitous economic malfeasance.

Granovetter reacted by pointing out that Williamson's conception of an economic actor is 'undersocialized'. Williamson views economic actors (individuals or firms) as isolated, concerned with their self-interest and seeing others solely as competitors. According to Granovetter, this is not the case in actual economic life. He claims that market participants tend to develop lasting relationships, i.e. repetitively engage in transactions with the same partners. In these relationships malfeasance is less likely than cooperation, and this is for reasons completely different than those that Williamson emphasizes. This is because actors know and trust each other. Their economic action cannot be understood just as constant utility maximization, for it is greatly shaped by social relations with their partners; to use Granovetter's favorite term, it is embedded in those relations. Where this is the case, vertical integration is unnecessary; if it nevertheless happens, it is because people trust each other and even derive pleasure from interacting with the same partners and colleagues (Granovetter 1985: 498).

Venture capital is a textbook example of non-hierarchical network-based economic community, and Granovetter's argument has been successfully applied to explain its development (see e.g. Saxenian 1994). One of the ways in which trust develops among venture capitalists is repetitive collaboration in investment projects, i.e. stable co-investment partnership. Thus, I hypothesize that stability of partners has a positive effect on venture capital firms' and

their investment recipients' performance. Stable partnerships generate trust and thereby increase the potential for productive cooperation and eliminate incentives for malfeasance.

Admati and Pfleiderer (1994) point out another mechanism, related to the Granovetter-Williamson debate, through which co-investment networks may benefit venture capital firms. They argue that some members of venture investment syndicates gain information advantages over other members. The investors enjoying information advantages have an incentive to exploit these advantages later in the investment cycle at the cost of other investors. So, they will increase their equity share in the company shortly before it goes public if they know that this company's prospects are particularly attractive. If, on the contrary, the information that they have tells them that company's prospects look unfavorable, they will let others provide more capital in later rounds. Co-investment, Admati and Pfleiderer argue, provides a mechanism to control such opportunistic behavior of firms that enjoy informational advantages in later investment rounds. They suggest that an implicit agreement between venture capital firms must exist to maintain the same equity shares throughout all investment rounds. Gompers and Lerner (1999) find support for this suggestion in their data on venture-backed biotechnology firms from the period between 1978 and 1989.

Although Gompers and Lerner see Admati and Pfleiderer's argument as one possible answer to the question 'Why do venture capitalists syndicate investments?', the answer is hardly complete. It adduces an explanation of why firms keep co-investing once they started doing so, not why they co-invest in the first place. Besides, the idea that maintaining stable investment shares indicates that venture capitalists are trying to avoid exploitation of information asymmetries is merely a guess. This rationale has been attributed to venture capitalists without obtaining first-hand evidence from them.

This said, we must acknowledge that Admati and Pfleiderer suggested a practicable way to operationalize opportunism. Relying on their ideas, one can calculate a measure of opportunism for both individual firms and whole networks of firms as a function of change in the equity share of syndicate partners. Williamson's reasoning implies that opportunistic behavior in the absence of vertical integration is rewarding for an economic actor. Williamson's opponents would probably argue that in the long run it is self-destructive, especially if actors heavily depend on their social networks. I will leave it to the data to decide which of the two predictions holds. If the impact of opportunism can be clearly interpreted as supporting Williamson or his critics, we should probably hold back our doubts about the validity of the measure that Admati and Pfleiderer suggested.

Thirdly, I argue that co-investment networks provide a mechanism for *sharing and management of expertise and experience* (Gompers and Lerner 1999: 187-188). Investing with experienced partners brings additional expertise into the investors' decision-making process and thus reduces the risk of making bad decisions. Conversely, investments made by or with inexperienced venture capital firms are considered riskier. So, established venture capital firms avoid investing with inexperienced investors in the early investment stages, especially in the seed investment round, because this would involve admitting those investors into the early decision-making stages where most crucial decisions are made. Yet they may syndicate their investments with inexperienced investors in later rounds. In this way less experienced investors get an opportunity of acquiring experience without taking excessive risks, and co-investment networks perform a surprising function of a training institution for beginning venture capitalists. The above gives us the reason to hypothesize that co-investment has a positive effect on venture

capital firms' and their investment recipients' performance inasmuch as it creates a mechanism for optimal distribution of investment expertise.

Risk sharing and management is yet another mechanism apparently at work in co-investment networks. Some venture capital firms take more risks by frequently investing in start-up companies; others try to minimize risks by investing mainly in later investment rounds. Both types of investors are dependent on each other: risk-takers often need additional funds in later investment rounds which can be supplied by conservative investors; conservatives investors, on the other hand, cannot stick to their strategy unless risk-takers nourish the companies in early stages. The dynamics of risk sharing and its implications for the outcomes of investment recipient companies are not well understood. The process may be seen either as symbiosis, or as a variation of 'specialization' (see e.g. Carroll 1985), or as a cynical zero-sum game where investors are trying to free-ride. My analysis will examine the relationship between the extent of risk sharing among companies' investors and the companies' economic outcomes.

Data and Measures

My data were extracted from the SDC Platinum database. SDC Platinum purports to record every venture investment in the world made since the early 1970s. I selected only those companies that were founded and received venture funding from 1970 through 2002. Earlier data are incomplete and come from the period when venture capital did not exist as a distinct industry. Where necessary, e.g. in computing the firms' experience, I use available data from all years. This yields a sample of 6,486 firms investing in 29,568 companies. (For the sake of clarity, I

refer to investor organizations as 'firms' and to their investment recipients as 'companies' throughout this paper.)

I use the specification of Cox regression for competing risks suggested by Lunn and McNeil (1995) to study the effects of VC firms' network mechanisms on their portfolio companies' outcomes. I construct a discrete-time model with year as the time interval. This is a good approximation of continuous time models (de Graaf and Kalmijn 2003:1477). Going public is the favorable exit event in the analysis; bankruptcy or liquidation constitute the unfavorable exit event. In the absence of reliable data on acquisitions, which is another common exit option for venture-backed companies, the companies that were neither public nor bankrupt nor liquidated by the end of 2002 are censored. Note that the incidence of favorable exits exceeds that of unfavorable exits by a margin of almost 3 to 1. On the one hand, one could argue that low failure rates are exactly what the venture capitalists' due diligence procedures, which all companies in the data have gone through, are intended to achieve. Therefore, low failure rates among venture-funded companies in comparison to other companies should not be surprising. This is probably part of the explanation. However, I suspect that the other part is that bankruptcies and liquidations are underreported in the SDC Platinum data, so the results for this outcome should be treated with more caution than the results for initial public offerings (IPO).

The basic competing risks model includes covariates alongside each covariate's interaction with a dummy indicator of failure type. Before this model is run, the dataset is expanded to add $N \times (t - 1)$ additional cases, where N is the initial number of cases and t is the number of different failure types. The added cases are identical to the initial cases except in the dummy indicators of failure type, which are necessarily different in the initial and the added cases. If there are just two failure types in such a design, the regression coefficients of the

covariates are the effects on the hazard type coded as "0" (IPO in this case) and the coefficients of the interaction terms are the effects of the same covariates on the hazard type coded as "1" (bankruptcy or liquidation). The choice of the best further specification of this basic model depends on the test of the assumption that the ratio of baseline hazard functions for all competing risks is constant (often called the proportional hazard assumption). The log-log plot (see figure 1) is a simple graphic test of the assumption: if the ratio is constant, the function lines for all failure types are parallel. Figure 1 suggests that this is not the case: the lines are diverging rather than parallel. The statistical test based on Schoenfeld residuals supports this conclusion (rho = -0.29; $p < 0.001$). Therefore, I choose the Cox regression stratified by failure type (Lunn and McNeil 1995: 526). The results in this specification do not depend on the hazard proportionality for the two types of failure and, although just one model is being fitted, are identical to those obtained by fitting separate models for the two failure types.

[Figure 1 about here]

I define two venture capital firms as having a network tie if they invest together in a company in the same investment round at least once in a given calendar year. Using co-investment ties to operationalize social connections in the VC industry admittedly does not capture the whole complexity of interfirm relationships, yet it is a standard and reliable indicator.

To construct the yearly measure of co-investment partner stability, I compared the egocentric networks of co-investment partners in the given and the preceding year for those venture capital firms that invested in two successive years. The index of partner stability for each

firm was calculated as the number of partners in the current year who were partners also in at least one of the previous two years, divided by the total number of current partners:

$$S_{fy} = \frac{T_{f\,(y\,-\,1)} \cap T_{fy}}{T_{fy}},$$

where T_{fy} is the set of co-investment ties of the venture capital firm f in year y. To obtain the aggregate measure of network stability for a company's investor firms, I compute the average of investors' partner stability indices S_{fy} weighted by their investment contribution to the company:

$$S_{cy} = \frac{\sum_{f} S_{fy}\, W_{fcy}}{F_c},$$

where F_c is the total number of investors in company c and the investment contribution weight is

$$W_{fcy} = \frac{I_{fc}}{\sum_{f} I_{fc}}.$$

I_{fc} denotes the investment amount of firm f in company c. The overall network stability index can be calculated as the ratio of the number of stable ties and the total number of ties among the firms that invested in the focal and the preceding year. Note that network stability is undefined for a firm if it is an isolate, i.e. has no co-investment ties in a given year.

The information asymmetry exploitation index (IAEI) was initially computed for each firm in each investment round where it participated. For each firm in each round except the first

one (the measure is undetermined in the first round because there is no comparison base), it is defined as the absolute value of the difference between the firm's share in the focal and the preceding investment round. This measure is then averaged across all firms investing in a company and rounds in which they participate:

$$(IAEI)_c = \frac{\sum_f \sum_r \left| I_f r - I_{f\,(r\,-\,1)} \right|}{\sum_f R_f},$$

where r indexes the investment round ($r \geq 2$), R_f is the number of investment rounds where firm f participated, and the other notations are the same as above. Obviously, the measure is undefined if the company had just one investment round. The network-level IAEI is the average of company-level indices computed for all investment rounds in a given period.

The venture capital firm's experience in a given year is calculated as the natural logarithm of the number of investments it had made by the beginning of that year. Computing the logarithm of the number of investments makes this measure correspond better to the underlying theoretical concept of experience, which is hardly a linear function of the number of investments made. The logarithmic measure reflects the idea that the marginal experience acquired in investing is decreasing rather than constant. Averaged across each company's investors and weighted by their contribution W_{fcy}, this measure enters the company-level regression model below. I also report results based on age as an alternative measure of firms' experience (see figure 3b in the next section).

To gauge the experience sharing among the company's investors, I dichotomized the experience variable. The newcomers to the industry in a given year are coded as inexperienced

in that year and the firms that entered earlier are coded as experienced. (The proportion of inexperienced active venture capital firms rose above 30 percent in the second half of the 1990s, but generally remained just below 20 percent.) The experience sharing variable has three categories: 1) at least one inexperienced investor in the first investment round; 2) inexperienced investor(s) in a later but not the first round; 3) only experienced investors.

Investors' readiness to take higher risks, or risk tolerance, is expressed as the share of their all-time total investment that they invested in startups. Averaging this indicator across all firms investing in a company (weight W_{fcy} applied here again) brings it to the company level of analysis. I also compute within-company standard deviation of this indicator to get to the idea of risk sharing among venture investors. High standard deviation indicates that investors with different degrees of risk tolerance fund the company. Low standard deviation, on the contrary, signals that partners with a similar propensity to take risk formed the syndicate. The standard deviation of zero is assigned to companies having just one investor.

The network indicators described above are summarized in table 1. They will be the independent variables in my regression analysis. The control variables are (1) the average betweenness centrality of the company's investors, (2) a dummy variable indicating whether the company is located in Silicon Valley, (3) the company's industry group, (4) the proportion of network isolates among the company's investors, and (5) the interaction of the proportion of network isolates with the network stability indicator S_{cy}.

The last control variable requires a further comment. The network stability indicator S_{fy} is undefined for isolates, i.e. for those venture capital firms that never co-invest in the same investment round with other firms in a given year. Therefore, if some of the company's investors are isolates, this indicator is computed from an incomplete set of its investors. The interaction

term will help determine how the effect of network stability depends on the completeness of the investor set. If the effect of the interaction term proved negligible, this would suggest that investor set completeness does not affect the results. However, inclusion of the interaction term does not solve the incompleteness problem when all company's investors are isolates (this is the case for 54 per cent of the companies). S_{cy} cannot be computed for such companies, so they are not included in the event history analysis. To understand how being an isolate affects their performance and whether excluding the companies funded by isolate investors introduces selection on the dependent variable, I will compare their hazards of IPO and failure to those of other companies.

Please see table 1 for a descriptive summary of the measures introduced in this section and table 2 for means, standard deviations, and a correlation matrix of all independent variables in the analysis.

[Table 1 about here]

[Table 2 about here]

Findings

Co-Investment Network Dynamics since the 1980s

Can we detect meaningful trends in the evolution of the venture capital co-investment network? In this section I will apply the suggested measures of co-investment network

mechanisms to describe this evolution, looking most closely at the period between 1986 and 2001 and in some parts going back to 1980.

Let us first examine the stability of co-investment partners. The number of investment ties quadrupled between the late 1980s and 2000. This happened because of the increase in the number of investors (figure 2a), not due to the networks becoming denser – the density of venture capital co-investment network has been falling steadily and dramatically in the 1990s. Recall that the stability index of venture capital co-investment networks, plotted in figure 2b, reflects the general level of investors' commitment to stable co-investment partners. After remarkable growth in the second half of the 1980s, the partner stability index entered a ten-year period of decline. While over a third of co-investment ties in 1990 were continued from the previous two-year period, only 15 percent of the ties in 2000 made it from the previous period. The trend of decline in stability was sharply reversed after 2000. The firms started returning to the strategy of co-investing with stable partners, and 23 percent of the ties in 2002 were stable.

[Figure 2 about here]

Turning now to investors' experience, let us examine the change over time in two different measures of experience. The first measure, used in constructing the experience variables for the regression, is the total number of investments that a firm has made. The second measure is the investing firm's age, i.e. years since its establishment. Means and medians of both indicators tend to grow over time because the age and the cumulative number of investments of the most active and well-established venture capital firms increase. However, as can be seen in

figure 3, such growth has not been smooth and monotonic. There was a remarkable decline starting in 1994-1995. It lasted until the growth resumed in 1999-2000.

So, here we again witness a trend being reversed around the time of the onset of economic recession. This nearly simultaneous reversal of trends in network stability and investors' experience deserves further attention and interpretation. I will return to this finding after examining the effects of co-investment network mechanisms on investment recipients' performance.

[Figure 3 about here]

The network-level information asymmetry exploitation index, defined as the average change in firms' investment share from round to round, is shown in figure 4. The index exhibits no trend except, perhaps, less stability in the 1990s and more before and after the 1990s. It varies little over time. Another thing to notice is that it is not in agreement with the claim of Gompers and Lerner (1999), who report that venture capitalists try to keep their investment shares constant from round to round. The share changes on average by approximately 25 percentage points each year in our observation period. This is not a trivial change. In fact, Gompers and Lerner got similar numbers but interpreted them as supporting the constant share hypothesis. In their dataset, the absolute round-to-round change in the stake is between 5 and 25 percent for half of the investors and it exceeds 25 percent for nearly 30 percent of them (1999:198). It is hard to agree that these results show that the stakes of each individual investor get preserved from round to round.

[Figure 4 about here]

Effects of Venture Investor Network Mechanisms on Investment Outcomes

One cautionary note is due before presenting and interpreting the results. The tricky question about the data is whether they should be considered a population or a sample. On the one hand, the data collectors aimed at recording every venture investment announced in the press or elsewhere. On the other hand, they certainly did not attain this goal; yet how much they fell short of it is unknown. Given this uncertainty, I chose to report the statistical significance of the estimated parameters in regression but will put little emphasis on it, focusing instead on the size of the hazard ratios.

Let us now turn to model 1 in table 3, which estimates the effects of all the covariates described above except the IAEI. The first result to notice is that the interaction term *partner stability ×proportion of network isolates* has a weak effect on the hazard rate (the hazard ratio is close to unity). Also, the change in the effect of the partner stability variable is negligible compared to the model with no interaction term (not shown). This suggests that we can interpret this effect without fearing that it depends on the completeness of the investor set. We see that a unit increase in the investors' partner stability decreases the company's hazard rate of going public by a third and the hazard rate of company failure by 11 percent, ceteris paribus. Thus, partner stability makes both the negative and the positive outcome less likely.

[Table 3 about here]

The experience of investors does not affect the hazard rate of either of the two outcomes we examine. Neither does experience sharing have a sizeable impact. There is no difference in outcomes between those companies whose seed investors were newcomers to the industry, those where newcomers were kept out of the seed round but entered later, and those whose investors were all experienced. This result certainly does not indicate that experience sharing is absent from the VC syndication networks. It suggests that, whatever the extent and the intended function of experience sharing, it does not affect the performance of the companies funded by venture capital firms.

Moving further, we notice that the companies whose investors take more risks by investing in startups faced a high failure risk and a low chance of going public. The lower chance of going public for companies nurtured by risk-prone investors is a noteworthy result. The high failure rate among such companies, by contrast, should probably not be emphasized given the unreliability of the failure data. The heterogeneity of investors in terms of their risk taking creeds strongly increased the hazard of both types of company exit. To put it another way, the risk that a company would experience no exit, either positive or negative, fell sharply with investors having different risk taking histories participating in the syndicate.

Examining the theta parameter offers some additional telling results. Theta is the difference between the same covariate's regression coefficients, computed as ln(hazard ratio IPO) - ln(hazard ratio B/L). A large absolute value of theta suggests that distinguishing the two risk types is justified. A theta close to zero suggests that the effect of the covariate is similar for both risk types, so regarding them as a single exit risk would not discard any significant information on the effect of this covariate. Note that theta is small and statistically insignificant for all our independent variables of interest except the propensity of investors to take risks. So,

we have to conclude that investor network mechanisms generally affect the risk of a positive and a negative outcome in a similar direction: they either increase or decrease both risks at the same time, or leave both risk types unaffected.

The only difference between model 2 and model 1 is the inclusion of the information asymmetry exploitation indicator. One unit increase in the IAEI increases the hazard rate of going public by 28 percent and decreases the hazard rate of company failure by 18 percent. On the one hand, the fact that the analysis has revealed sizeable effects suggests that there is substantive content to this measure. On the other hand, note that the IAEI has a high proportion of missing values, so adding it to the model removes more than 25 percent of the cases from the analysis. This loss of cases is certainly not random, as we see substantial changes in the effects of several covariates compared to model 1. The changes are not due to correlation between the IAEI and those covariates, as this correlation is weak, but rather to systematic incompleteness of the data due to missing values. This warrants caution when interpreting the effect of the IAEI.

The companies whose investors were network isolates were not included in this analysis. As an attempt to understand their performance, consider the comparison of hazard rates of exit in figure 6. The companies funded by network isolates do not differ from other companies in terms of the hazard rate of IPO or failure. This demonstrates that excluding the network isolates did not introduce systematic selection on the dependent variable and thus increases the confidence in the regression results.

[Figure 5 about here]

Can Rigid Social Networks Facilitate Technological Breakthroughs?

The conception of this work relied on terms having strong positive connotations. I suggested that venture capital co-investment networks generate trust and embeddedness, provide mechanisms for better experience sharing and for sharing and management of risks. The economic outcomes of investment recipient companies were hypothesized to improve 1) when more trust and embeddedness among its investors is present; 2) when investors are experienced, or when the lack of experience of some investors is compensated by experience of their co-investment partners; and 3) when the risks are optimally managed. In part this was a strategy of comparing the reality against an ideal type, yet mostly it was driven by the intuitively credible and theoretically grounded reasoning that embeddedness, experience, and wise risk management are important assets for an economic actor.

The initial descriptive results gave indirect support to this reasoning. During the boom of the second half of the 1990s, the co-investment partners of active venture capital firms were becoming increasingly casual and the experience of investing firms was declining. Yet at the onset of the recession the firms leaned towards partner stability and experience. This development easily lends itself to interpretation in positively connoted terms. One may reason that in the time of prosperity venture capitalists perceived less need for the benefits that they could derive from co-investing with trusted and experienced partners. The revenue expectations were high, the entrepreneurs' business plans seemed to work, so the investors did not bother to seek additional expertise and security that experienced and stable partners could provide. Yet when the recession came, the venture capitalists returned to more rewarding conservative

strategies: they re-established their stable ties to partners and searched for expertise that would enable them to distinguish between better and worse business projects.

However, the examination of network mechanisms' effects on investment recipients' outcomes suggests that such conservative co-investment strategy is not clearly beneficial. Stability of investment partners makes any outcomes, positive or negative, less likely. The outcomes of companies 'coached' by experienced investors do not differ from those of other companies. Likewise, the syndicates that optimize experience and risks by including investors with different levels of experience or different risk taking creeds do not offer clear benefits to the funded companies. The only finding that testifies to the benefit of conservative investment is that companies funded by risk-prone investors are less likely to go public and more likely to fail. Yet note that risky investment strategy implies a higher failure rate by definition and does not necessarily indicate low overall performance. As the conventional wisdom of venture capitalists goes, you can lose your money only once but you can get it back hundredfold.

Two broader challenges arise in light of these results. The first is understanding why embeddedness, experience and risk management are not clear economic advantages for venture capitalists, even though there are cited as advantages by venture capitalists themselves. One path that could lead to the answer was suggested by the work of Brian Uzzi (1997). Relying on his data on New York City apparel industry, Uzzi argued that there is an optimal level of embeddedness for economic actors; deviating to either side from this level has negative consequences for actors' outcomes. I performed a simple test of Uzzi's hypothesis by converting the partner stability index into a z-score, squaring it, and including in the regression model. This did not lend support to the hypothesis, so the puzzle remains to be solved.

The second challenge is understanding the relationship between venture capitalists' conservative business style and the general situation in the industry. The intuitively credible and empirically supported proposition is that economic actors tend to form stable partnerships under uncertain economic conditions even if forfeiting better opportunities with other partners (Kollock 1994). This suggests one possible reason why the conservative turn in VC firms' partner stability and experience coincided with the burst of the bubble in venture-funded high technology industry: the uncertainty about the success prospects that came with the recession was the causal antecedent of venture investors' conservative strategies.

However, I urge the reader to entertain the possibility of opposite causality here. While conservative network building strategy was hardly responsible for the 2000 crisis in high technology industry, it may be an obstacle to overcoming it. As Sandefur and Laumann (1998) point out, social capital has ambivalent organizational implications. On the one hand, it is an important asset for individual and collective actors as it generates benefits like information, influence and social solidarity. On the other hand they claim, in line with Portes and Sensenbrenner (1993), that social capital may lead to excessive social control and 'stifle innovation [...] by restricting the scope of individual expression and the extent of extracommunity contact' (Sandefur and Laumann 1998: 493). In other words, they warn that dense social networks tend to suppress unconventional ideas and inhibit the flow of non-redundant information.

If so, then can rigid embedded networks of the 'coaches' of high technology facilitate industrial breakthroughs like the one in the second half of the 1990s? The tentative answer is no. It seems that venture capitalists with a bold vision and readiness to take risks detected and developed the pathbreaking technological ideas of the 1990s and economically benefited from

them. By contrast, the conservative investors who have been in ascendance during the recession appear to have invested in less revolutionary projects. Rearrangement of venture capital networks and influx of investors ready to support unconventional ideas may be necessary before these networks can facilitate a technological breakthrough of the magnitude that we witnessed in the 1990s.

Note

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TABLES

Table 1. Mechanisms of Venture Capital Co-Investment Networks and Corresponding Measures

Mechanisms	**Measures**	**Measured Qualities**	
		Firm/Company Level	**Network Level**
Trust generation	Partner Stability Index	Embeddedness; Presence of stable trusted partners	General level of embeddedness
Opportunism prevention	Information Asymmetry Exploitation Index (IAEI)	Opportunistic economic behavior	General level of opportunistic economic behavior
Experience sharing and management	Extent of inexperienced investors' involvement in company	Consideration of risks coming from lack of experience	-
Risk sharing and management	Std. deviation of risk-proneness indicator of company's investors	Heterogeneity of investors in terms of risk-proneness	-

Table 2. Means, Standard Deviations, and Correlations of Independent Variables

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Average betweenness centrality	.53	.93															
2. Proportion of network isolates	.56	.48	0														
3. Interaction var2 × var10	.14	.20	.07	.67													
4. Company in Silicon Valley	.09	.28	.12	0	-.02												
5. Biotechnology	.04	.20	.03	0	-.01	-.05											
6. Communications and media	.14	.35	-.01	0	-.02	.04	-.12										
7. Computer related	.32	.47	-.02	0	-.03	.07	-.20	-.38									
8. Medical	.08	.27	.04	0	.01	-.04	-.09	-.16	-.29								
9. Semicond. and other electronics	.06	.24	.03	-.01	-.02	.11	-.07	-.13	-.22	-.10							
10. Partner stability (S_{cy})	.26	.21	.14	.02	.58	-.03	-.02	-.03	-.06	.02	-.02						
11. ln(experience)	3.38	1.58	.26	0	.31	.01	-.04	-.02	-.06	.02	-.03	.55					
12. Risky investment strategy	.06	.11	.08	.01	.12	.02	.04	-.06	-.03	.04	0	.22	.05				
13. Inexp. investors in 1st round	.17	.38	0	-.06	-.04	.01	0	-.01	-.01	0	.01	.01	.01	.01			
14. Inexp. investors in later round	.07	.25	0	-.23	-.15	.01	.01	0	-.01	.01	.02	-.01	-.02	-.01	-.12		
15. SD of risk taking strategies	.01	.03	.11	.02	-.09	.09	.06	-.02	.01	.05	.03	-.18	-.20	.14	-.01	0	
16. IAEI	.27	.24	0	-.01	-.05	.03	.02	-.01	.06	0	0	-.07	-.07	-.04	.01	.01	.05

Table 3. Stratified Cox Regression Hazard Ratio Estimates for Competing Exit Risks of Venture Capital Recipient Companies

	Model 1 (13,428 cases at risk)			**Model 2** (10,015 cases at risk)		
	IPO	**B/L**	**Theta**	**IPO**	**B/L**	**Theta**
Control Variables: Investor Characteristics						
Average betweenness centrality	1.07**	.98	.09	1.10**	.97	.13*
Proportion of network isolates	1.13	.95	.17	1.22*	.87	.34
Partner stability × Proportion of network isolates	.83	.94	-.12	.63	1.17	-.62
Control Variables: Company Characteristics						
Company in Silicon Valley	1.34**	1.09	.21	1.32**	1.05	.23
Industry						
Biotechnology	3.05**	.24**	2.53**	2.67**	.21**	2.52**
Communications and media	1.53**	.99	.43*	1.42**	.99	.37
Computer related	1.09	1.64**	-.41*	.97	1.62**	-.51*
Medical	1.77**	.44**	1.39**	1.52**	.40**	1.33**
Semiconductors and other electronics	1.40**	.46**	1.12**	1.23*	.43**	1.06**
Variables of Interest: Investor Characteristics						
Partner stability (S_{cy})	.66*	.89	-.30	.45**	1.41	-1.15
ln(experience)	1.04	.95	.10	1.08**	.91*	.17**
Risky investment strategy	.53*	3.50**	-1.89**	.61	1.75	-1.04
Experience Sharing						
Inexperienced investors in 1st round	1.02	.97	.05	1.00	1.00	0
Inexperienced investors in later but not 1st round	1.15	.99	.15	1.15	.97	.17
SD of risk taking strategies	5.77*	5.51	.05	7.13*	2.74	.96
Information asymmetry exploitation index				1.28*	.82	.44
Failure Events	2,062	706		1,675	560	

Note: Industry categories are major industry groups distinguished by Venture Economics (reference category 'Non-high technology'). Reference category for experience sharing is 'No inexperienced investors'. B/L stands for bankruptcy or liquidation. The parameter theta is the difference between the same covariate's regression coefficients, i.e. ln(hazard ratio IPO) - ln(hazard ratio B/L).

* $p < .05$ ** $p < .01$ (two-tailed tests assuming sample data)

FIGURES

Figure 1: Testing for the Proportional Hazard Assumption: Log-Log Plot by Type of Companies' Exit

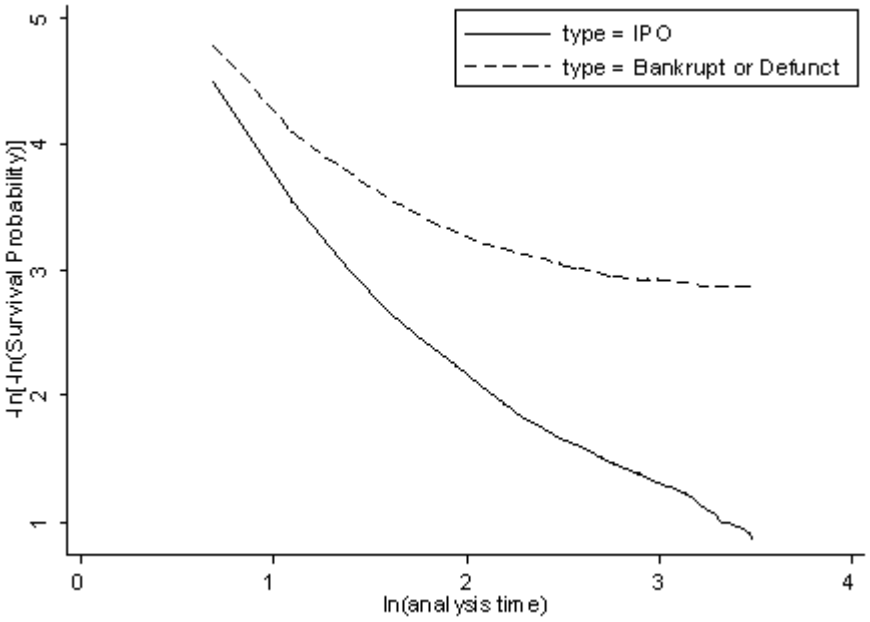
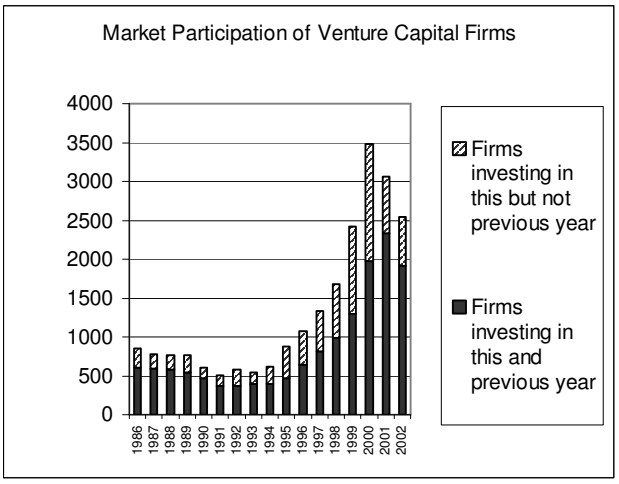
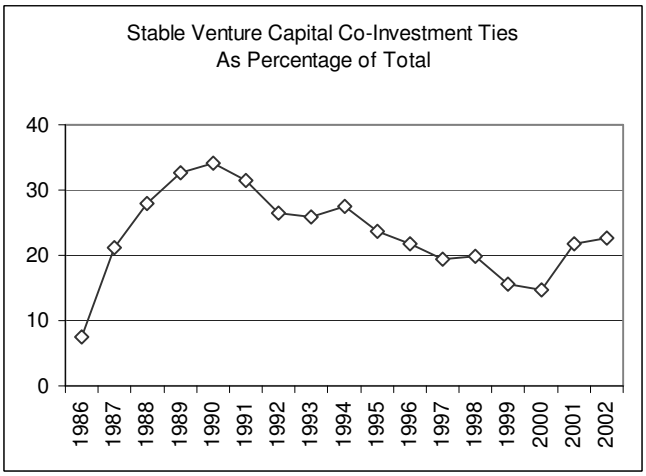


Figure 2. Stability of Venture Capital Firms' Market Participation and Their Co-Investment Ties, 1986-2001



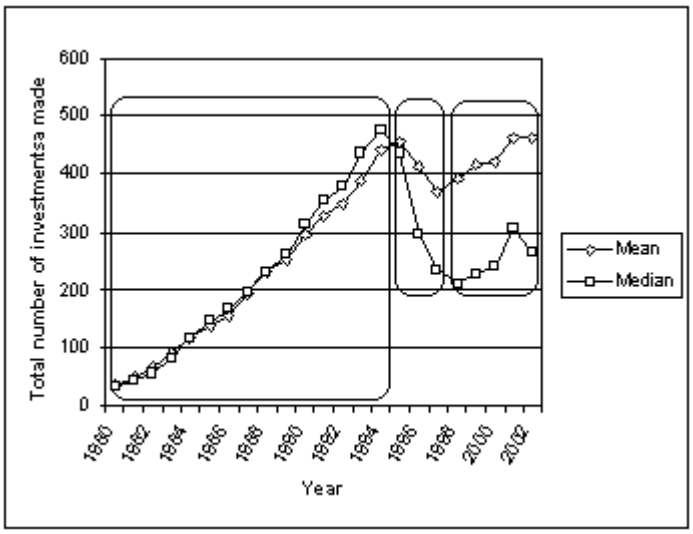
(a)



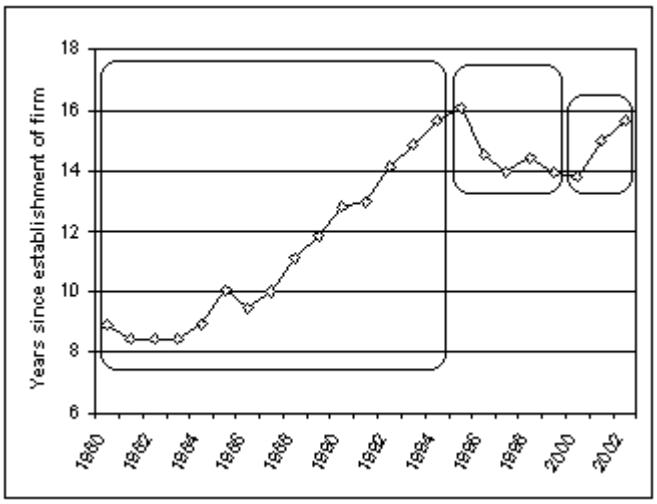
(b)

Note: Ties are considered stable if they existed in one or both of the previous two calendar years.

Figure 3. Experience of Venture Capital Investors, 1980-2002



(a)



(b)

Note: The median and the mean are not distinguished in Figure 2(b) because they roughly coincide. The measures are calculated only for firms that invest during a given year.

Figure 4. Average Round-to-Round Change of Investment Share in Venture Capital Recipient Companies, 1985-2001

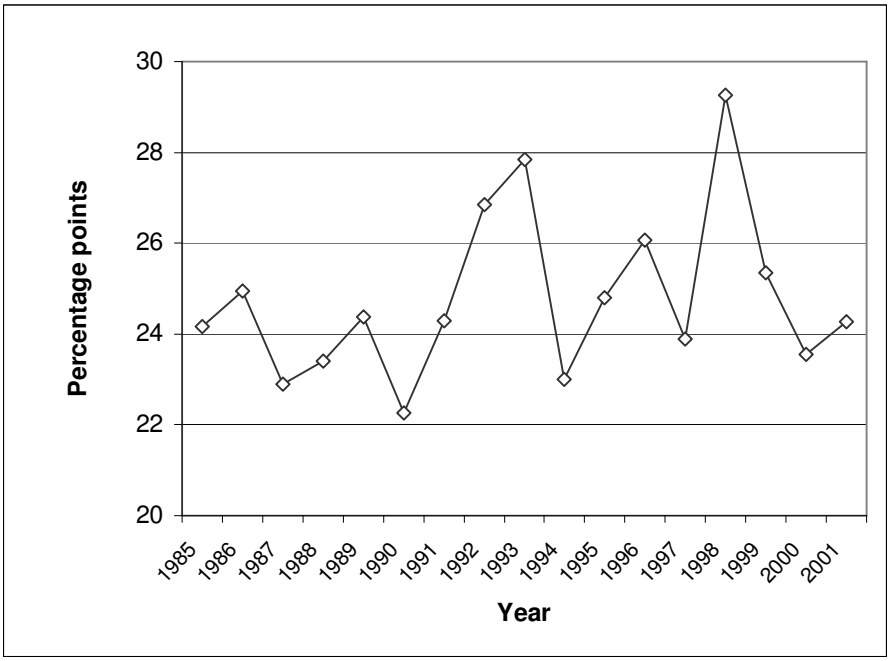


Figure 5. Hazard of Company Exit vs. Company Age by Exit Type and Isolate Status