SMALL FISH, BIG FISH: THE PERFORMANCE EFFECTS OF THE RELATIVE STANDING IN PARTNERS' AFFILIATE PORTFOLIOS

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Running head: Relative Standing in Partners' Portfolios and Performance

Keywords: Relative Standing, Affiliation Portfolios, Venture Capital, Portfolio Size, Status

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Abstract

This study examines whether the value a venture derives from an affiliation depends on its relative standing in the portfolio of all affiliations held by its partner. Relative standing refers to how the venture ranks among other ventures in the partner's portfolio with respect to expected returns. The relative standing of a venture in its partner's portfolio influences the venture's access to the partner's resources and the venture's performance. We also argue that a venture's relative standing becomes more important to performance when the partner has a larger portfolio or higher status. In addition to a field study, we test the effect of a venture's relative standing in a venture capital portfolio on its exit likelihood, controlling for endogeneity. We find support for our hypotheses.

INTRODUCTION

Ventures face an uphill battle in securing critical resources for survival and growth (Stinchcombe, 1965). Affiliations with established organizations help ventures access critical resources and capabilities, and endorse ventures' quality in the eyes of other market participants (e.g., Gulati & Higgins, 2003; Megginson & Weiss, 1991; Stuart, Hoang, & Hybels, 1999). These affiliations can take different forms, such as equity investments and alliances, and involve different partners, such as venture capital (VC) firms, established firms in a venture's industry, and universities (Gulati & Higgins, 2003; Hallen, 2008; Powell, Koput, & SmithDoerr, 1996).

While early work has focused on the dyadic relationships between a given venture and a partner, scholars have recently begun to explore the implications of a portfolio approach to affiliations. The interest on affiliation portfolios is timely, given that affiliations with multiple partners are increasingly common. For instance, an examination of all VC investments between 1962 and 2008, as reported by Thomson Reuters, shows that an average VC portfolio includes 23 ventures. Recent work suggests that many firms approach and configure their affiliations as portfolios (e.g., Kale, Dyer, & Singh, 2002; Lavie, 2007; Ozcan & Eisenhardt, 2009).

Several studies have delved into the question of how firms manage their affiliation portfolios to increase performance (e.g., Bae & Gargiulo, 2004; Baum, Calabrese, & Silverman, 2000; Lahiri & Narayanan, 2013; Lavie, 2007). The related question of how a *partner's* portfolio of affiliations influences the focal venture has been so far underexplored. The few studies that touched on this topic focused mainly on the positive externalities from a partner's other affiliations, and did not focus on the structure of the affiliation portfolio (e.g., Stuart *et al.*, 1999). There has not been an explicit account of how the structure and composition of a partner's portfolio of affiliations and a venture's relative standing in this portfolio might influence the affiliation benefits for the venture.

This paper aims to fill this gap by asking how a venture's relative standing in its partner's portfolio influences its performance. We argue that the extent to which the focal venture will benefit from a given affiliation is, among other factors, a function of how it ranks among all ventures in its partner's portfolio in terms of expected returns to the partner. Put differently, two ventures of the same absolute quality may perform differently based on their relative standing in their partners' portfolios.

The study makes several contributions to the literature on organizational strategy. First, this is one of the few studies to demonstrate the performance implications of resource constraints and intra-portfolio competition for resources in the context of interorganizational affiliations (Fulghieri & Sevilir, 2009; Gifford, 1997; Sahlman, 1990). We develop a new construct, *relative standing*, which captures the importance of each venture with respect to other ventures in a partner's portfolio. We suggest that a venture's relative standing in its partner's portfolio with respect to signals of quality influences its access to the partner's resources, and in turn, its performance. As such, this study is the first to explore relative standing within an affiliation portfolio and provide empirical evidence of its economic impact on venture performance.

Second, we demonstrate that the performance impact of a venture's relative standing in its partner's portfolio increases with the size of the partner's portfolio and the partner's status. This finding extends prior work in entrepreneurship and strategy that explores the contingency factors influencing interorganizational affiliation benefits (Gulati & Higgins, 2003; Lavie, 2007; Sapienza, 1992). We identify a previously ignored factor, relative standing, as a contingency factor that may limit or enhance affiliation benefits to a venture.

AFFILIATIONS AND VENTURE PERFORMANCE

Studies of interorganizational affiliations suggest three types of affiliation benefits to ventures. First is access to partners' resources. Affiliations with established organizations provide the venture with access to complementary resources for commercialization (e.g., Pisano, 1994; Teece, 1992), while affiliations with VC firms provide access to financial capital (Gompers & Lerner, 2000; Gulati & Higgins, 2003).

Second, affiliations facilitate interorganizational learning by allowing access to a partner's technological or operational know-how (Hagedoorn & Schakenraad, 1994; Shan, Walker, &

Kogut, 1994; Stuart, 2000). VC firms often help ventures recruit executives and formulate a product-market strategy through face-to-face interactions or board memberships, or by serving as a sounding board for key decisions (e.g., Barney *et al.*, 1996; Gorman & Sahlman, 1989; Hellmann & Puri, 2002; Macmillan, Kulow, & Khoylian, 1989; Sahlman, 1990; Sapienza, 1992). Furthermore, affiliations with established organizations, and with VCs in particular, give ventures timely access to information about the presence, quality, and trustworthiness of other potential exchange partners (Gulati, 1998, 1999).

Affiliations also provide endorsement benefits. The fact that a high-status firm has selected a venture as a partner signals a positive evaluation of the venture's prospects, and shapes the perceptions of other market participants (Stuart *et al.*, 1999). Having high-status VC firms as investors allows ventures to attract other investors, suppliers, customers, and IPO underwriters (Gulati & Higgins, 2003; Megginson & Weiss, 1991; Stuart *et al.*, 1999).

Taken together, affiliations enhance venture performance through resource, knowledge, and endorsement benefits. Many studies therefore emphasize that ventures are more likely to succeed if they have more affiliations (Baum *et al.*, 2000) and if they affiliate with resource-rich, high-status partners (Chung, Singh, & Lee, 2000; Stuart, 2000; Stuart *et al.*, 1999).

Do all ventures benefit equally from affiliations?

While affiliations may help ventures assemble necessary resources, provide knowledge, and endorse quality, establishing an affiliation does not guarantee uniform access to a partner's resources. Some studies assert that the extent of benefits that ventures receive from their partners depends on the cooperative relationship in the dyad. Ventures benefit more from affiliations when there is mutual trust, cooperation and knowledge-sharing in the dyad (Dyer & Singh, 1998). For instance, ventures have higher performance when they have more opportunities for

VC interaction and involvement (e.g., Sapienza, 1992) and a history of joint experience that fosters trust (e.g., Barney *et al.*, 1996; DeClercq & Sapienza, 2001).

Other studies approach interorganizational affiliations as a rent-distribution problem between partners (see Dyer, Singh, & Kale, 2008, for a review.) Building on resource-dependence and exchange theories (Emerson, 1967; Pfeffer & Salancik, 1978), this body of work suggests that the extent to which a focal firm benefits from a given affiliation depends on the nature of the dependency and power dynamics between the focal firm and the partner. These studies examine the attributes of the parties involved, as well as the composition and the structure of the *focal* firm's portfolio of affiliations, as determinants of a focal firm's power and its potential to benefit from a given affiliation (e.g., Bae & Gargiulo, 2004; Lavie, 2007). Interestingly, the body of work that examines affiliation benefits has paid little attention to how a *partner's* affiliation portfolio may influence the benefits to a focal venture.

The composition of the partner's affiliation portfolio may be an important determinant of benefits from an affiliation. Studies examining interorganizational affiliations from a network perspective often implicitly or explicitly consider the implications of partners' other affiliations and generally emphasize positive externalities. For instance, in their study of the performance implications of interorganizational endorsements, Stuart *et al.* (1999) found that ventures whose partners maintain more alliances have higher performance. Such partners may contribute more to the focal venture because of their affiliation experience and the connections they can leverage. Similarly, Hochberg *et al*. (2007) show that ventures benefit more from affiliations with VCs that occupy central positions in the VC syndicate network. While these studies have significantly increased our understanding of how partners' affiliations may influence the focal organization, they did not consider how resource constraints and competition among members of an affiliation

portfolio may influence the focal venture's performance. In the subsequent sections, we explore the implications of resource constraints and intra-portfolio competition, and focus our attention on a venture's relative standing in a partner's portfolio as a determinant of the benefits to a venture.

Resource constraints, intra-portfolio competition, and affiliation benefits

We argue that the composition of a partner's venture portfolio may influence the focal venture's performance by increasing intra-portfolio competition. If a partner's resources were unbounded, each venture that established an affiliation with the partner could enjoy unlimited benefits. However, many tangible resources, such as financial capital, as well as intangible resources, such as managerial attention and effort, are limited (Levinthal & Wu, 2010; March & Simon, 1958). Aggarwal (2012) suggests that a venture may suffer from a partner's resource congestion, especially when the venture's and the partner's activities overlap. Gifford (1997) and Fulghieri and Sevilir (2009) show through analytical models that the constraints on VC firms' human resources and attention influence both the entrepreneurs' and the VCs' incentives to exert effort. In addition, relational resources, such as endorsements, may be constrained because they derive their value in part from exclusivity (Podolny, 1994). As a result, ventures that are in the same partner's portfolio may find themselves in competition for the partner's resources.

In short, while prior literature has established some factors that cause ventures to benefit differentially from their affiliations, there is little understanding of how the structure of a partner's portfolio, and in particular, a venture's relative standing with respect to the other ventures within that portfolio, affects the extent of the benefits that the venture receives from its partners. Next, we report the results of a field study that explores these issues in the VC industry, and then proceed to develop hypotheses and conduct an empirical test.

RESULTS OF A FIELD STUDY IN THE VC INDUSTRY

To explore the impact of a partner's portfolio of ventures on the focal venture, we first conducted a field study of VC firms, followed by a large-sample study. We chose to focus on the VC industry for several reasons. First, VC firms typically form portfolios of investments in multiple ventures. Second, the benefits of VC affiliations for ventures have been well documented in the literature (e.g., Hellmann & Puri, 2002; Megginson & Weiss, 1991; Sorenson & Stuart, 2001). Third, the resources provided by VC investors are relatively homogeneous (e.g., Dushnitsky & Lavie, 2010), making portfolio comparisons more meaningful.

Our field study began with semi-structured interviews with eight VC professionals, each lasting between 45 and 90 minutes. While these interviews can neither provide definitive evidence nor the in-depth insights available from a complete qualitative study, they provide preliminary evidence suggesting a relationship between affiliation portfolios and performance. We later develop and test these arguments in a large-sample analysis. We summarize the interview findings below, removing all names to preserve confidentiality.

First, we would like to point out that our respondents did not espouse a view of ventures as interchangeable investments, but emphasized that they exert every effort to ensure the well being of each venture in their portfolio. VC funds often allocate a capital reserve for each venture to be used as needed in the future. Each general partner in a VC firm takes primary responsibility for a limited number of ventures so that each venture gets the time and attention required to succeed.

Despite these safeguards, the unpredictability of venture progress, coupled with the low overall success rate of new ventures, creates an imperative to reevaluate each venture against others. VC investors typically follow the development of their ventures through board memberships and frequent interaction. They evaluate each venture periodically with a detailed

review of the venture's progress against milestones set in earlier rounds of financing. In the biotechnology industry, these milestones may include research and development advancements, patent applications, FDA application and approval, human clinical trials during the FDA application process, and licenses and other strategic alliances that enable the firm to access funding and other resources. When resources are scarce, VC firms selectively allocate them by comparing the ventures in their portfolio to one another based on their expected returns. It is well understood that only a small proportion of ventures in a VC's portfolio ultimately succeed, so VCs tend to allocate their resources to the ventures that have a better chance of being profitable. As one VC put it,

> So venture capital partnerships, in their Monday morning meetings, say, 'We have a finite number of dollars left here. Say we have $50 million to invest in the next two years. And assume we can't raise new money for five years—let's assume the worst case. So we've got $50 million, we've got 10 companies that need $10 million each. So we've got half of the capital to provide to our companies or we'll get washed out. So which ones of our children do we let survive? Which ones do we let die?' [VCs] are having these kinds of candid discussions...And therefore they're all basically looking at this as a capitalistic function —How do we make the most money, or lose the least money?' —And they're making a decision.

Our respondents suggested that in such cases, allocation may be based on the signals of quality of the ventures in the portfolio. For instance,

> The way I look at this is, as a venture capitalist I look at a company in terms of what milestones need to be accomplished in order to either file for a public offering or get a strategic investor to want to buy a company….and if we have a scarcity of dollars and a lot of companies that need capital in our portfolio I'll look at the ones that are most likely to get to the finish line to liquidity the first, second, third, fourth. I rank them in terms of how likely they are to get to a liquidity event, and what time frame.

The interviews also strongly suggested that allocation based on the relative standing of portfolio ventures may be more important for VC firms with larger portfolios, or for ones with high status. For instance, one VC commented that portfolio size influences the allocation of human capital and expertise within a VC firm because there is more competition for the time and

attention of the most experienced partners when the portfolio is larger: 'Bigger portfolio, there's definitely a pyramid effect of human resources. So you're going to have lots of junior partners managing this stuff.' Similarly, these respondents pointed out that a venture's access to a VC firm's resources might be more limited when the VC has high status, partly because the quality of the ventures increases resource competition, and also because such VCs may be selective in promoting their ventures. For instance,

> If you are in [a high-status investor's] fund, and they are in Google, and YouTube, and everybody else, and you are not doing as well as them, are you going to get the [top partner], the most senior guy, and his office time and his effort? No, you may get some associate.
>
> The [high-status funds] are in the business of promoting stars, touting companies. When you are touting companies, you can't tout all 40 companies, right?... We live in a sound-bite world, you know. You need to pick a few, set an agenda. Have a focus in your touting. Pick a few to be influential. Can't use your brand name on all 40 of them…Who would you talk about in meetings, cocktail parties?

In sum, our interviews provided preliminary evidence that VC firms need to make resource allocation decisions, and in doing that, they tend to prioritize ventures with the highest expected returns. Moreover, they suggested that portfolio size and VC status may intensify the competition for resources within a portfolio.

Relative standing in the partner's portfolio and benefits to affiliation

The above discussion suggested a series of predictions about the implications of partners' resource constraints and intra-portfolio competition on the benefits each venture can receive from a given partner. Below we develop hypotheses that predict a relationship between a venture's relative standing in its partner's portfolio and its performance.

Given partners' resource limitations and the multiple claims on those resources, partners are likely to selectively allocate their resources among the ventures in their portfolio, creating intra-portfolio competition (Gifford, 1997; Sahlman, 1990). How does the partner allocate its

resources among the ventures in its portfolio? We expect a boundedly rational partner to rank the ventures in its portfolio according to the expected return from each, such that ventures that have better future prospects, and hence are expected to bring higher returns to the partner, rank higher, and receive more resources. This is especially likely to be the case in contexts in which high uncertainty prevents a precise initial selection of investments, and a small proportion of ventures generate the majority of the returns in the portfolio, such as VC investments (Scherer, Harhoff, & Kukies, 2000). In such cases, partners are especially likely to put emphasis on ventures that they expect will have better future prospects and bring higher returns to the partners.

The ranking process among portfolio ventures is akin to the pre-partnership ranking process that is well established in the affiliations literature. Previous work documents that firms rank their potential exchange partners before forming an affiliation based on the expected returns from each (e.g., Gulati & Gargiulo, 1999). Each firm aims to match with the highest quality ventures possible (e.g., Shipilov, Rowley, & Aharonson, 2006). Signals of quality are frequently interpreted as positional attributes of the potential exchange partners, and provide the basis for ranking potential partners among all organizations in the population (Dushnitsky & Shaver, 2009; Hallen, 2008; Podolny, 1994; Shipilov, 2005).

We suggest that partners will continue ranking portfolio ventures *after* forming affiliations and that they will base resource allocation decisions on those rankings. Portfolio rankings will depend on a partner's assessment of each venture's expected returns. As in pre-partnership formation, partners are likely to infer expected returns from observable signals of quality (Shipilov *et al.*, 2006). Ventures that provide stronger signals of quality will thus acquire a preferential standing in the portfolio.

Ventures with a higher relative standing than the other ventures in the partner's portfolio will enjoy better access to their partners' resources. Partners allocate more resources and attention to ventures with higher relative standings because they expect higher returns from these ventures. Improved access to resources in turn leads ventures with higher relative standing to benefit more from a given affiliation. Conversely, ventures that rank lower in a partner's portfolio may have more limited access to the partner's resources and benefit less from the affiliation than higher-ranking ventures in the same portfolio.

While it is difficult to precisely determine the extent of benefits from an affiliation, one of the most well-accepted indicators of partnership benefits (value-added) in the VC literature is the venture's exit performance, because the multiplex of activities performed and resources provided by VC firms are inextricably linked to the possibility of a successful exit (e.g., Bottazzi, Da Rin, & Hellmann, 2008; Hochberg *et al.*, 2007; Sørensen, 2007). The main goal of most VC firms is to realize returns on their investment in ventures through exit events in the form of IPOs or sales through M&As (Bottazzi *et al.*, 2008; Gompers & Lerner, 2000; Hochberg *et al.*, 2007; Lee & Wahal, 2004). This is backed by studies that show that a venture is more likely to exit when VCs add more value to the venture (Bottazzi *et al.*, 2008; Jääskeläinen, Maula, & Seppa, 2006). It should be noted that venture performance may reflect the quality of the ventures (selection) as well as the contribution of the partners (value added) (Bottazzi *et al.*, 2008; Hellmann & Puri, 2000; Sørensen, 2007). Therefore, inferring partnership benefits from venture performance requires ruling out selection effects, which we address in the methods section.

It is also important to note that relative standing in a partner's portfolio is conceptually and empirically distinct from the absolute quality of a venture. Relative standing is based on signals of intrinsic quality and indicates where a particular venture stands with respect to the other

ventures in partner's portfolio based on signals of quality. Therefore, while absolute quality and relative standing may be correlated (e.g., the highest quality ventures may rank highly in their partners' portfolios), the two are distinct in the sense that relative standing also depends on the quality of the *other* ventures in the partner's portfolio (e.g., a venture that ranks highly in a portfolio of average-quality ventures may have a lower standing in a portfolio of high-quality ventures). In other words, relative standing adds to the notion of quality the *competition* between ventures in a given portfolio for the limited resources of the partner. We therefore expect that, controlling for the selection bias and absolute venture quality, a venture with a higher relative standing in its partner's portfolio will perform better than a venture with a lower relative standing.

Hypothesis 1. After controlling for selection effects, the higher the relative standing of a venture with respect to the other ventures in its partners' portfolio, the higher the performance of the venture.

Partners' portfolio size, relative standing, and venture performance

If indeed a partner's resource constraints cause intra-portfolio competition and influence the affiliation benefits available to the ventures in a portfolio, we expect relative standing to be more critical to venture performance when resource constraints are more severe and intra-portfolio competition is more intense. In this section, we argue that the size of the partner's portfolio of affiliations, *i.e.* the number of ventures in the partner's portfolio competing for resources, is likely to increase the impact of relative standing on venture performance.

Relative standing in a partner's portfolio may be more important to a venture's performance when the portfolio in question is large, for two reasons. First, greater demands on the partner's resources create more intense competition for those resources among the ventures in the

portfolio. Especially when the resource in question cannot be easily expanded, such as attention or effort, larger portfolios may limit the share of the resource available to each venture (Fulghieri & Sevilir, 2009; Jääskeläinen *et al.*, 2006; Levinthal & Wu, 2010). Prior research has documented problems that organizations face in the case of information or activity overload from managing multiple parallel projects (e.g., Castellaneta & Zollo, 2014). In such cases, a venture's relative standing will have an even stronger effect on how much of the partner's limited resources it can access. Hence, assuming similar resource endowments, relative standing becomes more important to venture performance when there are more ventures in the portfolio.

Second, according to the resource-dependence perspective, a partner with more ventures in its portfolio will have more leverage over each venture and more control over resource allocation (Pfeffer & Salancik, 1978). Prior research suggests that having a larger number of affiliations increases the partner's power by providing the partner with more alternatives (Baum *et al.*, 2000; Lavie, 2007). Hence, a partner with a larger portfolio of ventures has more flexibility to focus on the most promising ventures and to reduce its involvement in lower-ranked ventures. Alternatively, a partner with a smaller portfolio may have a higher dependence on each venture and must ensure that each perform well. This suggests that partners with larger portfolios of ventures are more likely to support ventures that are relatively more important to their own performance, perhaps at the expense of the lower-ranked ventures, while partners with smaller ventures may implement a more even allocation of resources across all ventures in the portfolio. We therefore expect,

Hypothesis 2. After controlling for selection effects, the size of the partner's portfolio is likely to positively moderate the impact of the venture's relative standing in the partner's portfolio on the venture's performance.

Partners' status, relative standing, and venture performance

Next, we turn to how relative standing influences endorsement benefits, a significant contributor to a venture's performance (e.g., Gulati & Higgins, 2003; Stuart *et al.*, 1999). We suggest that the impact of a venture's relative standing in a partner's portfolio on the venture's performance will be even more pronounced when the partner has high status.

As highlighted in the previous sections, the literature emphasizes the benefits of affiliating with high-status partners (Stuart, 2000; Stuart *et al.*, 1999). Endorsement by high-status partners signals that the venture is high quality and hence facilitates access to other network partners (e.g., Stuart *et al.*, 1999). Much less discussed is the cost that ventures incur by affiliating with high-status partners. One such cost has been documented by Hsu (2004), who found that ventures take a monetary discount to affiliate with high-status VCs.

In addition to the explicit monetary costs of affiliating with a high-status VC firm, we argue that ventures may incur an additional, hidden cost through the ranking process. The relative standing of a venture in the partner's portfolio may influence the benefits of affiliating with a high-status partner, because high-status partners are likely to be more discriminating than the average partner in extending endorsement benefits to the ventures in their portfolios. While relational resources such as status do not deplete with use, they may lose value in use due to two principles. First, because status derives value from exclusivity (Podolny, 1994), status benefits may depreciate if a high-status partner indiscriminately endorses a large number of ventures. Second, status may 'leak' if a high-status partner becomes associated with lower-quality ventures (Podolny, 2005). Since others look to high-status firms to evaluate intrinsic quality of the ventures, high-status firms must be discriminating in providing endorsements in order to preserve their own status (Stuart, 2000). Empirical evidence suggests that organizations seek associations with actors of their own status rank in order to avoid status leaks (e.g., Podolny,

1994). Therefore, we expect high-status partners to extend endorsement benefits in a way that will preserve and increase their own status positions (e.g., Shipilov, 2005).

Moreover, we expect high-status partners to extend endorsements in a discriminating manner even after the initial selection of ventures. Endorsement is typically characterized as a dichotomous variable that is equally available to all affiliates (e.g., Stuart *et al.*, 1999), with the underlying assumption that high-status partners passively grant endorsement through association. In contrast, we suggest that endorsement may come in degrees, especially if it involves active commitment and support from a high-status partner. Although all ventures in a high-status partner's portfolio may enjoy some degree of endorsement merely by association, the ventures that rank higher in the high-status partner's portfolio may receive more enthusiastic support. For instance, a high-status VC firm may introduce its most promising ventures to other high-status investors (Gompers & Lerner, 2000), assign them to prominent venture capital professionals within the firm, or show more pronounced support for them during the IPO process. In this way, the partner not only preserves the overall status homophily by associating its highest quality ventures with its highest quality contacts, but also enhances its own status (Shipilov *et al.*, 2006).

A low-ranked venture in a high-status partner's portfolio may still benefit from the partner's status, albeit to a much lower extent. Such a venture may receive a weaker endorsement by the high-status partner, such as less-involved introductions to key contacts or assignments to lesser-known professionals within the VC firm. In the absence of a strong endorsement from high-status partners, and given the higher *ex ante* costs of associating with such partners (Hsu, 2004), a low-ranked venture may find it difficult to recoup the *ex ante* cost of affiliation.

Hypothesis 3. After controlling for selection effects, the status of the partner is likely to positively moderate the impact of the relative standing of a venture in its partner's portfolio on the venture's performance.

DATA AND METHODS

We test our hypotheses through an analysis of the VC investments in biotech ventures. We focus on the ventures in the biotechnology industry in order to reduce heterogeneity among ventures, and because prior research and available data on the biotechnology industry provides a solid basis to establish observable signals of quality. It is also significant that prior research identifies affiliations with VC firms as an important type of partnership for biotechnology start-ups, along with alliances with pharmaceutical companies and universities (Higgins & Gulati, 2003; Hochberg *et al.*, 2007; Powell *et al.*, 1996). We formed a unique data set by combining data from several sources. We collected data on VC investment in biotechnology firms from Thomson Reuters (formerly VentureXpert.) We obtained data on ventures' alliances from Deloitte Recap LLC. We collected data on the patent applications of biotechnology ventures from NBER (Hall, Jaffe, & Trajtenberg, 2001) and from the USPTO website. We collected fund size data from Preqin. We compiled the stage of the venture in the FDA approval process from Thomson, FDA website and Factiva. As in prior studies, we excluded VC investments before 1980 because data pertaining to that period are not reliable (Hochberg *et al.*, 2007).

Methodology

Prior literature suggests that the match between a particular investor (e.g., VCs in our context) and investees (e.g., ventures) may not be random (e.g., Ackerberg & Botticini, 2002; Bottazzi *et al.*, 2008; Sørensen, 2007). In particular, ventures may prefer to match with particular VCs, leading to a selection bias, which in turn would make the ventures' relative standing endogenous. This bias might confound the treatment effect of relative standing.

In order to separately identify the treatment effect of relative standing, we control for possible selection bias in our analyses using a 2-stage model following the previous literature

(Bottazzi *et al.*, 2008; Heckman, 1979). In the first stage (i.e., selection model), we estimate the likelihood of a match between a particular VC firm and a particular venture and calculate the inverse Mills ratio based on this estimation. In the second stage, where we estimate the venture's likelihood of exit, we include the inverse Mills ratio along with the other controls. The selection model enables us to control for the nonrandomness of VC investment in a venture, i.e., the endogeneity of the match between VC firm and the venture. That way, we are able to obtain unbiased estimates of the treatment effect of relative standing on the venture's performance above and beyond the impact of a possible selection bias.

First stage (Selection model). In the first stage, we conduct probit regression to estimate the likelihood of a match between a particular VC firm and a venture. Following Sørensen (2007), our sample includes all possible pairs (realized and unrealized) between VC firms and US-based biotechnology ventures between 1982–1996. A realized pair occurs when a VC firm invests in a venture as a lead investor in the venture's first investment round. In that case, the dependent variable in the selection model takes on one; otherwise it takes on zero. Including all possible VC-venture pairs (88,176 observations) enables us to allow various factors affecting the match between a VC firm and a venture to be incorporated in the selection model.

Previous literature uses 'the availability of investors in the local geographic market' as an instrument to address the non-random match between investors (e.g., VCs) and investees (e.g., ventures) in a variety of contexts (e.g., Ackerberg & Botticini, 2002; Berger *et al.*, 2005; Hellmann, Lindsey, & Puri, 2008). We also use the 'availability of the VCs in the venture's local geographic market' as an instrumental variable to address the nonrandomness of the match between the VCs and the ventures. We chose this instrument firstly because the distribution of the VCs in the market is exogenous. Second, the availability of VCs in a market affects the

likelihood that a particular venture is matched with a certain VC (Sorenson & Stuart, 2001, 2008) and is thus associated with the relative standing of a venture in a VC's portfolio. Yet, once the match between a particular VC and a particular venture occurs, the availability of VC firms in the venture's local market should not affect venture performance (Ackerberg & Botticini, 2002; Berger *et al.*, 2005; Hellmann *et al.*, 2008). We therefore used alternative instrumental variables pertaining to the availability of VCs in the venture's local geographic market.

We measured the availability of investors in the local geographic market using the total number of VC funds investing in the venture's local geographic market in a given year. In unreported analyses we have also used the density of the VC fund investments in the venture's local geographic market and the total number of VC investment rounds made in the venture's local geographic market and received qualitatively similar results. Our diagnostic analyses confirm the validity of the all three instrumental variables. In particular, market-level VC count affects the likelihood of match, yet does not affect the venture's exit likelihood. Both the Hausman (1978) and Stock and Yogo (2005) tests confirmed that our instrument was valid and strong. The other instrumental variables also confirm to the restrictions described above.

As in Sørensen (2007), we define the venture's local geographic market based on the state the venture is headquartered and the half-year in which the venture seeks VC funding. We have three state categories in total (CA, MA and other), and 15 *2=30 half-year categories between 1982 and 1996, resulting in 30*3=90 markets in our sample. In the selection model, in addition to the instrumental variable, we include several other control variables that might influence the VC-venture match, such as the stage, age, alliance count, and patent count of the venture, and VC fund size. We included the inverse Mills ratio from the first stage as a control in the second stage model (e.g., Bottazzi *et al.*, 2008; Heckman, 1979).

Second stage (outcome) model. In the second stage, we run probit analyses, where the dependent variable is whether the venture exits through IPO or M&A by the end of 2004. We only included realized pairs of VCs and ventures in this stage, in which a VC firm actually invests in a venture as lead investor in a venture's first round. In our sample, there are 401 realized VC-venture pairs of investment. Our final sample includes 227 pairs since the remaining pairs have missing data due to the U.S. dollar (USD) amount of VC investment in the venture or VC fund size. There is no statistically significant difference between the mean stage, alliance count, patent count, or age of the ventures across these two groups. Since our sample includes ventures that received first VC investments between 1980 and 1996, we have a sufficient time lag to observe exits between the last observation time of 1996 and the last observed exit year of 2004 (Sørensen, 2007). As we explained above, we included the inverse Mills ratio from the selection model as a control variable in the second stage model. So the coefficients of relative standing on Tables 2-4 show unbiased estimates of the treatment effect of relative standing on the venture's exit likelihood. While this analysis is static in the sense that it does not take into account changes in relative standing over time, we have conducted dynamic analyses with Cox regression models, as reported below.

Dependent variable: Successful exit

In the second stage, in which we estimate the effect of relative standing on a venture's exit likelihood, the dependent variable takes on one if the venture exits through IPO or M&A by the end of 2004, and zero otherwise. Conventional measures of performance are not available for private biotechnology ventures since most ventures do not have marketable products and may be years away from a stable revenue stream (DeCarolis & Deeds, 1999; Pisano, 1996). Hence, it is neither appropriate nor possible to use measures such as profit margins or sales growth to

measure performance (DeCarolis & Deeds, 1999).

An IPO is an important strategic objective for private biotechnology ventures as it enables the ventures to sell stocks to the public, creating a critical source of funding and liquidity (Bottazzi *et al.*, 2008; DeCarolis & Deeds, 1999; Gompers *et al.*, 2010; Gompers & Lerner, 2000; Ozmel, Robinson, & Stuart, 2013b; Sørensen, 2007). An IPO is also one of the primary ways for VC firms to realize their return on investment in a venture (Guler, 2007; Hochberg *et al.*, 2007; Lee & Wahal, 2004). In addition, M&As have become prevalent routes of exit especially during the past decade (e.g., Giniatullina *et al.*, 2013). Therefore when a VC firm is able to add value to a venture, the VC firm realizes its profit through these exit events.

Independent variable: Relative standing

We calculate relative standing of a venture in a VC's portfolio using a direct indicator of a VC's assessment of a venture's quality signals: the size of the investment the VC has already made in the venture. If a VC has a positive evaluation of a venture's prospects, it is likely to have invested a larger amount. We therefore calculate our measure of relative standing with respect to VC's investment size (in USD) in the venture:

Relative standing of venture i in VC j's portfolio with respect to VC investment size =

= (VC investment in venture i – Mean VC investment in the other ventures in VC j's portfolio)/Standard deviation of the VC investment in the other ventures in VC j's portfolio)

In robustness tests reported below, we also calculate relative standing for each venture with respect to i) stage of the venture's products with the FDA; and ii) alliance count, and get similar results.

Control variables

We measure *VC status* by calculating Bonacich's (1987) *power centrality* in the syndication network (e.g., Nerkar & Paruchuri, 2005; Podolny, 1993; 1994; Sorenson & Stuart, 2001):

$$\text{Centrality of the VC firm}_{i,t} = C_{i,t} = \sum_{j=1}^{N_t} (\alpha_t + \delta_t c_{j,t}) R_{i,j,t}$$

where $c_{j,t}$ is the centrality of VC firm j at year t, and $R_{i,j,t}$ is the relationship matrix that shows the number of co-investments between VC firms i and j for the time period between t-5 and t. N_t is the total number of VC firms that were active at any time between t and t-5. δ_t is the weighting coefficient set equal to 0.75 of the reciprocal of the largest eigen-value of R (e.g., Jensen, 2003; Podolny, 1993). We set α so that the maximum centrality for each year is equal to one. We also control for *VC portfolio size,* which is the number of ventures funded by the VC within the past five years (Gompers & Lerner, 2000; Hsu, 2004). *VC fund size* is the (million USD) size of the VC's fund.

We control for venture maturity using venture's *age* and *stage. Age* is months elapsed since the venture's founding. *Stage* is a dummy variable indicating whether or not the venture's products have reached the clinical trials stage with the FDA (Adegbesan & Higgins, 2010; Ozmel *et al.*, 2013b). *Alliance count* shows the venture's alliance activity during the past five years (Gulati, 1998, 1999; Ozmel, Reuer, & Gulati, 2013a; Stuart *et al.*, 1999)**.** *Patent count* is the number of patents granted to the venture during the past five years and is a measure of the venture's innovativeness (e.g., DeCarolis & Deeds, 1999; Hagedoorn & Schakenraad, 1994; Stuart, 2000). We also control for the *VC investment size* in the venture (in millions of USD) , and *syndicate size,* or the number of the investors investing in the venture (Cumming, 2006; Jääskeläinen *et al.*, 2006). Last, we include a dummy variable that equals one if the venture operates in the 'pharmaceutical drug development' subsector (*Industry subcategory*). In order to

incorporate market conditions, we control for *the biotech market conditions,* calculated as the ratio of the number of biotechnology firms that went public during the prior three months to the total number of the private biotechnology firms. We also control for the *NASDAQ composite monthly index return (NASDAQ return*) to incorporate the market cyclicality in high-tech industries. In unreported models, we controlled for S&P 500 index return instead of NASDAQ return and have received similar results.

RESULTS

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

Table 1 presents the descriptive statistics and the correlations. The correlation between the absolute level of VC investment size and relative standing based on VC investment size is 0.40. This suggests that there is significant variation captured by the relative standing of a venture based on the VC investment that is not explained by the absolute investment level. A test for variance inflation factors shows no signs of multicollinearity.

We report the results of the selection model in Column 1 of Table 2, where we estimated the likelihood of a match between a VC firm and a particular venture with a probit model. We calculated the inverse Mills ratio using this estimation and included it in *all* of the second stage models reported in Tables 2-4 to control for the selection bias (although we report first stage results only in Table 2 due to space constraints.) Supporting Sørensen (2007), our selection model shows that the instrumental variable has a significant and negative impact on the match between the VC and the venture.

Columns 2-6 of Table 2 show the results of the second stage models, where we run probit regression models to estimate the effect of relative standing on the venture's exit likelihood. The dependent variable is whether or not the venture achieves a successful exit by the end of 2004.

Since we control for the selection bias in a VC's investment in the venture using inverse Mills ratio, the coefficients of the relative standing are unbiased estimates of the *treatment effect* of relative standing, due to value added by VC's. Note that in the second-stage models we only include the *realized* VC firm-venture pairs, i.e., only the pairs where the VC firm invests in the venture as a lead investor in the venture's first round between 1982-1996 (Bottazzi *et al.*, 2008; Sørensen, 2007).

In Column 2 of Table 2, we present the second stage regression results with control variables only. As shown in Table 2, we control for venture quality, maturity, VC characteristics and market conditions along with the inverse Mills ratio. In Columns 3-6, we use *relative standing with respect to the VC investment* in the venture. Column 3 includes the main effect of relative standing, and Columns 4 and 5 add the interaction effects with VC status and VC portfolio size, respectively. Column 6 is the full model.

Table 2 shows that the main effect of relative standing is positive and significant, supporting Hypothesis 1. The interactions are also positive and significant, which suggest that relative standing becomes more important when VC portfolio size is larger (H2) and when VC status is higher (H3). When everything is at its median, a one standard-deviation increase in VC status increases the impact of relative standing on the likelihood of exit by two percent; and a one standard deviation increase in VC portfolio size increases the impact of relative standing on the likelihood of exit by around four percent.

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

The Appendix illustrates the relationship between relative standing and exit likelihood under different levels of VC status and VC portfolio size. The plots show the impact of relative standing on exit likelihood when everything else is at its median, when VC status is at median

plus one standard deviation, and when VC portfolio size is at its median plus one standard deviation. These plots lend further support to our findings.

Robustness tests: Alternative measures, dynamic analyses and outliers

We calculated alternative measures of relative standing with respect to ventures' stage and alliance activity, which are proxies for observable signals of ventures' quality.

Relative standing with respect to stage. The development stage of the venture's products is a key indicator of the venture's prospects (e.g., Rothaermel & Deeds, 2004; Stuart *et al.*, 1999). In particular, starting clinical trials is a critical threshold for a biotechnology venture. Clinical trials on a product can only start after firms submit an investigational drug application (IND) to the FDA, present the results of their extensive preclinical trials, and receive clearance. This process takes several years, and the likelihood of a compound in the preclinical trial period reaching clinical trials is less than one in 100 (Grabowski, 2002; Rothaermel & Deeds, 2004; Stuart *et al.*, 1999). We calculate relative standing with respect to stage as,

Relative standing of venture i in VC j's portfolio with respect to venture i's stage =

= (Stage of venture i – Mean stage of the other ventures in VC j's portfolio)/Standard deviation of the stages of the other ventures in VC j's portfolio)

Relative standing with respect to alliance activity. Alliances are widespread in the biotechnology industry, and often include joint R&D and licensing agreements with large pharmaceutical firms (e.g., Deeds & Hill, 1996; Pisano, 2006; Rothaermel & Deeds, 2004). Alliances with established players provide positive signals of quality, both because these firms are trustworthy sources as evaluators, and also because such alliances are likely to improve the odds of a venture's survival and growth (Baum *et al.*, 2000; Gulati, 1998; Gulati & Gargiulo, 1999; Powell *et al.*, 1996; Shan *et al.*, 1994; Stuart *et al.*, 1999). Hence;

Relative standing of venture i in VC j's portfolio with respect to venture i's alliances = (Alliance count of venture i – Average alliance count of the other ventures in VC j's portfolio)/Standard deviation of the alliance count of the other ventures in VC j's portfolio).

The second-stage models shown in Table 3 are identical to the ones reported earlier, except that they show results with relative standing with respect to stage (Models 1 & 2) and alliances (Models 3 & 4.) Model 2 shows that the main effect of relative standing with respect to stage is positive and significant, as well as the interactions. Accordingly, when everything is at its median, one standard deviation increase in VC status increases the impact of relative standing-stage on the likelihood of exit by five percent and a one standard deviation increase in VC size increases the impact of relative standing-stage on the likelihood of exit by about three percent. In unreported analyses, we find that when relative standing-stage is the only right hand side variable (without controls), it does not have a significant impact. However, once we control for the NASDAQ return, stage, patent count and syndicate size, relative standing gains significance and its significance increases with the full set of controls as reported on Table 3.

Model 3 shows that relative standing based on alliances on the venture's exit likelihood is positive and significant (H1.) Model 4 shows the full model with the interactions. Model 4 suggests that the effect of relative standing is higher when VC portfolio size is larger (H2) and VC status is higher (H3). The main effect of relative standing continues to be significant and positive. When everything is at its median, a one standard-deviation increase in VC status increases the impact of relative standing with respect to alliances on the likelihood of exit by almost five percent; and a one standard-deviation increase in VC portfolio size increases the impact of relative standing on the likelihood of exit by around eight percent. In unreported analyses, we find that relative standing-alliances is not significant when it is the only right-hand

side variable. After controlling for the NASDAQ returns as the only right-hand side variable accompanying relative standing, the impact of relative standing with respect to alliance count becomes significant.

---------- *Insert Tables 3 and 4 about here* ----------

Dynamic (Cox) models. In addition, we also implemented Cox proportional hazard models to incorporate changes in relative standing over time (without the selection model.) This analysis is different from the static one reported earlier in several ways. First, the data is organized in venture-months, such that relative standing, performance, and all time-varying control variables are updated monthly, and they take into account the changes in VCs investing in a venture as well as changes in VC portfolios and hence relative standing over time. The number of observations is 33,779, and the sample includes 878 biotechnology ventures. Second, the dependent variable is defined as the hazard of exit (IPO or acquisition). Third, we ran Cox proportional hazards models with competing risks for exit or liquidation. Tests of the proportionality assumption reveal that the assumption is not violated, and the results are robust to uses of parametric models with alternative distributional assumptions, including Gompertz and Weibull, as well as to discrete-time hazard models. To account for a possible correlation across the error terms resulting from unobserved factors that do not change over time, we cluster the error terms at the venture level. In the further robustness tests we have repeated our analyses on dynamic data with panel logit analysis instead of hazard model and we received similar results.

In the dynamic analysis we described above, relative standing is also calculated with respect to stage, alliance activity, and amount of VC investment. The results are consistent with the two-stage selection models correcting for endogeneity, with the exception of the main effect of

relative standing-stage. Thus, the results of the hazard models corroborate our findings. The dynamic results with time-varying relative standing measures are provided in Table 5.

Furthermore, we excluded ventures in the top one percent in alliances and patents to alleviate a potential concern about outliers, and found our results remain similar.

DISCUSSION AND CONCLUSIONS

This study demonstrates that the impact of interorganizational affiliations on a venture's performance is in part determined by the venture's relative standing in its partner's affiliation portfolio. Through a two-stage model, we show that, after controlling for the selection bias in the VC's investment in the venture as well as the venture's absolute quality, the relative standing of a venture in a VC portfolio positively affects the venture's performance. In empirical analyses, we calculated relative standing with respect to the stage, the alliance activity of the venture, and VC investment size in the venture, both in static and dynamic analyses, and found support. Our results suggest that two ventures of the same quality may receive different benefits from their partnerships, depending on their relative standing in their partners' portfolios.

This study contributes to the literature on interorganizational affiliations by underscoring the importance of a venture's standing in an affiliation portfolio in determining the extent of benefits it extracts from its partnership. As such, it contributes to the burgeoning literature on affiliation portfolios and their impact on firm performance (e.g., Bae & Gargiulo, 2004; Lahiri & Narayanan, 2013; Lavie, 2007; Ozcan & Eisenhardt, 2009). Our paper also contributes to the contingency approach to affiliation benefits in entrepreneurship and strategy, which mainly focuses on the attributes of the partners or the dyad as determinants of affiliation benefits (e.g., Barney *et al.*, 1996; Dyer *et al.*, 2008; Lavie, 2007; Sapienza, 1992).

One of the primary contributions of this study is to demonstrate localized competition for resources in the context of interorganizational affiliations and the performance implications thereof. In building our argument, we highlight two aspects of partners' affiliation portfolios that are underemphasized in the previous literature: resource constraints and intra-portfolio competition for the partner's limited resources. Most previous studies on affiliations assume that partners' resources are unlimited, and affiliations are independent of one another. However, resource constraints may influence resource allocation decisions *across* portfolio investments (Fulghieri & Sevilir, 2009; Gifford, 1997). Furthermore, given that the partners have limited resources, there is intra-portfolio competition among ventures to access these resources. By showing that relative standing in a partner's portfolio affects the performance of the venture, we contribute to the previous and limited literature on resource competition (Aggarwal, 2012; Fulghieri & Sevilir, 2009). Another contribution of our study is to explore the implications of a post-selection ranking of partners, as opposed to a pre-partnership ranking of potential partners. Our findings suggest that, even after a partnership is formed, ventures must rank high in their partner's portfolio to achieve preferential access to their partner's resources.

Our results also contribute to the resource-based view (Barney, 1991; Barney, 1986; Penrose, 1959) by providing a view of how ventures accumulate resources depending on their position in partners' portfolios. Recent years have seen an increased interest in understanding the role of initial resource endowments and resource accumulation in the context of entrepreneurial firms (e.g., Alvarez & Busenitz, 2001; Baker & Nelson, 2005). Our empirical findings suggest two related insights. First, two ventures with identical initial resource endowments may perform differently due to their respective relative standings in their partners' portfolios. Second, forming affiliations with resource-rich partners may not be sufficient to ensure access to the partners'

resources. The focal venture's access to the partner's resources is in part determined by the venture's relative standing with respect to the other ventures in the partner's portfolio.

Generalizability of the measures. Even though we test our hypotheses in biotechnology, our relative standing measures apply to other contexts. Relative standing with respect to investment applies to all other ventures receiving funding or resources from other firms. The stage of ventures' products is an important measure for private companies not only in biotechnology but also in other high-tech industries. A venture's partners develop expectations regarding its future prospects by examining how developed its products are (e.g., Hallen, 2008). Similarly, alliances act as signals of quality in a wide variety of industries such as software, semiconductors, telecommunication and services, where there is uncertainty regarding the quality of the ventures (e.g., Gulati, 1995; Gulati, 1998, 1999; Kale *et al.*, 2002; Lavie, 2007; Sampson, 2005; Stuart, 2000; Stuart *et al.*, 1999).

Generalizability of VCs as exchange partners. This study focuses on ventures' affiliations with VC firms. We chose this setting because portfolios of affiliation are common in this context, and VCs face substantial uncertainty about the quality of the ventures in the portfolio when allocating their limited resources. Considering that many firms hold affiliation portfolios (e.g., Kale *et al.*, 2002; Lavie, 2007; Ozcan & Eisenhardt, 2009) and allocate scarce resources in their portfolios under uncertainty, we expect our findings to be generalizable to other affiliation contexts. Future research might examine whether our arguments apply equally well to other contexts and types of affiliations, such as alliances between two well-established firms.

In this paper we focus on private ventures' successful exits as a performance measure mainly because most of the private biotechnology ventures do not have revenue-generating products yet. Furthermore, VCs aim to take their successful portfolio companies to exit events in the form of

IPO or M&A in order to realize their investments in these portfolio companies. Future studies that focus on established companies can use different performance measures, such as profitability. In addition, because we could not observe the actual resource allocation decisions, we inferred their impact on ventures by observing successful exit events (e.g., Bottazzi *et al.*, 2008; Gompers *et al.*, 2010; Sørensen, 2007; Stuart *et al.*, 1999). Following prior literature, we took care to parse out VCs' value added from the selection effect through a two-stage analysis (Bottazzi *et al.*, 2008), so that our results capture the treatment effect of relative standing on venture performance. Future work can examine in more detail the process by which partner firms allocate their resources across ventures in their portfolios.

Limitations notwithstanding, this study provides a unique perspective on the extent to which ventures benefit from their affiliations, and the role that a venture's relative standing in its partner's portfolio plays on that venture's performance.

ACKNOWLEDGEMENTS

We would like to thank the Editor and three anonymous reviewers for their valuable suggestions on this paper. Umit Ozmel would like to thank her dissertation committee at Columbia Business School for their feedback and suggestions on a very early version of this paper. We also thank Richard Bettis, Thomas Brush, Gary Dushnitsky, Timothy B. Folta, Nandini Lahiri, Dovev Lavie, Atul Nerkar, Jeffrey J. Reuer, Deniz Yavuz, and participants who provided feedback in numerous seminars and conferences. Any remaining errors are ours. Isin Guler is a recipient of the BAGEP Research Award of Bilim Akademisi- the Science Academy, Turkey and GEBIP Research Award of TUBA Turkish Sciences Academy.

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Table 1 - Summary statistics and correlations

		Mean	Std Dev	1	2	3	4	5	6	7
1	Exit event (DV)	0.63	0.48	1.00						
2	Age (months)	24.24	23.7	-0.05	1.00					
3	Stage	0.24	0.43	-0.03	0.24	1.00				
4	VC investment size (log mio USD)	0.33	0.19	-0.08	0.10	0.16	1.00			
5	VC fund size (mio USD)	2.3	4.4	0.11	0.06	-0.03	0.00	1.00		
6	Syndicate size	4.25	2.26	0.30	0.26	-0.03	0.16	0.28	1.00	
7	Alliance count	0.37	0.76	-0.08	0.29	0.33	0.02	0.00	-0.05	1.00
8	Patent count	0.25	0.57	0.01	0.45	0.00	0.07	0.02	0.02	0.07
9	Industry Subcategory	0.87	0.34	-0.02	0.18	0.22	-0.04	0.02	0.02	0.11
10	NASDAQ return	0.00	0.07	-0.22	0.29	0.09	0.03	-0.14	-0.21	0.15
11	Biotech market conditions (*1000)	4.23	4.12	0.07	0.03	-0.21	0.19	0.08	0.12	-0.07
12	VC status (Log)	0.40	0.22	0.17	-0.13	-0.25	0.01	0.24	0.33	-0.22
13	VC portfolio size (*0.1)	1.77	1.87	0.06	-0.06	-0.10	-0.18	0.01	-0.06	-0.09
14	Rel. standing-VC investment size	-0.35	0.63	0.23	0.11	0.01	0.40	-0.02	-0.24	0.00
15	Rel. standing-VC inv size *VC status	-0.15	0.21	0.16	0.13	0.13	0.18	-0.05	-0.38	0.01
16	Rel. standing-VC inv size * VC portfolio size	-0.63	1.18	0.23	0.09	-0.02	0.21	-0.13	-0.10	0.04

*N=227. Correlations equal to or bigger than 0.14 are significant at 5% or higher.

Table 1-Correlations-continued

		8	9	10	11	12	13	14	15	16
8	Patent count	1.00								
9	Industry subcategory	0.01	1.00							
10	NASDAQ return	0.21	0.17	1.00						
11	Biotech market cond. (*1000)	0.02	-0.17	-0.13	1.00					
12	VC status (log)	-0.09	-0.18	-0.29	0.11	1.00				
13	VC portfolio size (*0.1)	0.12	-0.30	0.07	0.05	0.18	1.00			
14	Rel. standing-VC investment size	0.02	-0.13	0.03	-0.06	-0.13	0.02	1.00		
15	Rel. standing-VC inv size*VC status	0.08	-0.07	0.03	-0.15	-0.44	0.09	0.58	1.00	
16	Rel. standing-VC inv size* VC portfolio size	-0.11	-0.03	-0.11	0.02	0.00	-0.17	0.46	0.57	1.00

Table 2 - Selection model* and treatment effect of relative standing with respect to VC investment size on a venture's exit likelihood

	1st stage Selection model	2nd stage-Control model	2nd stage, Treatment effect of relative standing –VC investment on exit likelihood			
	1	2	3	4	5	6
Age	-0.00+	-0.00+	0.002	0.001	0.001	0.000
	(0.00)	(0.00)	(0.007)	(0.008)	(0.008)	(0.008)
Stage	-0.04	0.39	1.455**	1.411*	1.326*	1.331*
	(0.04)	(0.25)	(0.561)	(0.561)	(0.558)	(0.556)
VC investment size (log)		-0.48	-1.268+	-1.398+	-1.377+	-1.445+
		-0.42	(0.712)	(0.737)	(0.729)	(0.744)
VC fund size	0.00**	0.00+	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.000)	(0.000)	(0.000)	(0.000)
Syndicate size		0.18**	0.422**	0.460**	0.446**	0.471**
		(0.07)	(0.111)	(0.113)	(0.111)	(0.115)
Alliance count	-0.01	0.04	-0.056	1.469	-0.258	0.888
	(0.02)	(0.16)	(0.719)	(0.904)	(0.758)	(0.830)
Patent count	0.01	0.11	-0.020	-0.036	0.326+	0.209+
	(0.01)	(0.10)	(0.052)	(0.052)	(0.169)	(0.126)
Industry subcategory	0.03	0.45*	0.577	0.632	0.631	0.636
	(0.03)	(0.18)	(0.391)	(0.413)	(0.415)	(0.431)
NASDAQ return	0.00	0.30	-0.121	-0.107	-0.090	-0.063
	(0.17)	(1.26)	(0.197)	(0.187)	(0.220)	(0.211)
Biotech market conditions	0.01*	0.02	0.950**	0.987**	0.879**	0.918**
	(0.00)	(0.02)	(0.295)	(0.301)	(0.311)	(0.311)
VC status (log)		0.78+	-1.726	-1.642	-0.883	-1.103
		(0.43)	(2.483)	(2.549)	(2.511)	(2.581)
VC portfolio size (*0.1)		-0.00	0.010	0.017	0.018	0.020
		(0.03)	(0.034)	(0.038)	(0.037)	(0.039)
Relative standing			1.146**	0.823**	0.740**	0.599*
			(0.175)	(0.253)	(0.264)	(0.288)
Rel.standing * VC status				2.736*		2.060*
				(1.168)		(0.992)
Rel. standing * VC portfolio size					0.589*	0.403*
					(0.261)	(0.189)
Inverse Mills ratio		-10.40	-99.499+	-96.962+	-100.362+	-98.106+
		(36.03)	(56.882)	(57.025)	(56.469)	(56.506)
Instr var (VCs in venture's local geog. market)	-0.003**					
	(0.000)					
Constant	-2.36**	-0.66	-0.404	-0.579	-0.541	-0.631
	(0.04)	(0.85)	(0.475)	(0.476)	(0.479)	(0.483)
Log p-likelihood			-85	-82	-82	-80

*Selection model for the match between VC firm and the venture and control model are the same regardless of the relative standing measure used in the treatment model. ** , *, + represent 1, 5, and 10 % significance. N=227

Table 3 – Treatment effect of relative standing with respect to stage and alliances on exit likelihood

	1	2	3	4
Age	0.004	0.02	-0.030**	-0.028**
	-0.01	-0.013	-0.01	-0.01
Stage	-2.189*	-3.803**	0.826+	0.653
	-0.913	-1.112	-0.434	-0.515
VC investment size (log)	-2.739*	-1.888+	-1.762+	-1.243
	-1.246	-1.117	-0.917	-1.027
VC fund size	0	0	0.000+	0.000*
	0	0	0	0
Syndicate size	1.034**	1.122**	0.352*	0.335*
	-0.258	-0.276	-0.148	-0.151
Alliance count	-0.685*	-0.811+	-1.531**	-1.244**
	-0.286	-0.43	-0.333	-0.275
Patent count	0.994**	1.240**	0.718*	0.680*
	-0.336	-0.294	-0.306	-0.332
Industry subcategory	0.374	0.73	1.231*	1.339*
	-0.511	-0.516	-0.533	-0.57
NASDAQ return	-20.489**	-29.463**	-1.327	-3.457
	-5.623	-6.28	-2.621	-3.932
Biotech market conditions (*1000)	0.133*	0.138*	0.11	0.067
	-0.062	-0.062	-0.07	-0.067
VC status (log)	-1.606+	-0.315	0.913	4.368**
	-0.927	-1.177	-0.834	-1.457
VC portfolio size (*0.1)	-0.249+	-0.195	-0.066	0.372
	-0.137	-0.12	-0.116	-0.236
Relative standing –stage	1.315**	0.529*		
	-0.476	-0.259		
Rel. standing-stage * VC status		5.339*		
		-2.373		
Rel. standing-stage * VC portfolio size		0.294*		
		-0.136		
Relative standing – alliances			3.124**	1.189*
			-0.544	-0.557
Rel. standing - alliances * VC status				5.838*
				-2.325
Rel. standing - alliances * VC portfolio size				0.761*
				-0.386
Inverse Mills ratio	11.163	4.679	-13.676	-45.52
	-84.549	-81.345	-84.023	-96.289
Constant	-1.604	-0.510+	-0.030**	-0.028**
	-0.998	-0.292	-0.01	-0.01
Log p. likelihood	-49	-41	-67	-61

Standard errors in parentheses. ** , *, + represent 1, 5, and 10 % significance. N=227

Table 4. Cox proportional hazard model results for the impact of relative standing on the hazard of exit

	1		2		3		4		5		6	
Venture stage	0.046	(0.041)	0.083+	(0.044)	0.48**	(0.18)	0.59**	(0.17)	0.52**	(0.17)	0.54**	(0.17)
VC investment size	-0.038	(0.234)	0.005	(0.236)	0.11**	(0.04)	0.10*	(0.04)	0.11**	(0.04)	0.13**	(0.04)
VC fund size	0.599**	(0.175)	0.619**	(0.174)	0.04	(0.05)	0.04	(0.01)	0.06	(0.05)	0.05	(0.05)
Syndicate size	0.103**	(0.022)	0.104**	(0.022)	-0.06*	(0.03)	-0.05+	(0.03)	-0.05+	(0.03)	-0.05+	(0.03)
Alliance count	0.010**	(0.003)	0.010**	(0.003)	0.10**	(0.02)	0.10**	(0.02)	0.06**	(0.02)	0.07**	(0.02)
Patent count	0.026**	(0.008)	0.026**	(0.008)	0.02**	(0.01)	0.03**	(0.01)	0.03**	(0.01)	0.03**	(0.01)
Industry subcategory	0.264+	(0.145)	0.269+	(0.146)	0.21	(0.15)	0.26+	(0.15)	0.21	(0.15)	0.17	(0.15)
California headquarter (dummy)	-0.056*	(0.028)	-0.057*	(0.028)	0.12	(0.13)	0.1	(0.13)	0.04	(0.13)	0.02	(0.13)
Biotech market cond. (*1000)	0.140**	(0.013)	0.141**	(0.013)	0.15**	(0.01)	0.14**	(0.01)	0.14**	(0.01)	0.14**	(0.01)
NASDAQ return	-0.408	(0.654)	-0.407	(0.650)	-0.4	(0.67)	-0.4	(0.68)	-0.72	(0.72)	-0.85	(0.72)
VC status	0.462	(0.291)	0.253	(0.300)	0.67*	(0.29)	0.54+	(0.3)	0.85**	(0.28)	0.36	(0.37)
VC portfolio size (* 0.1)	-0.035**	(0.011)	-0.044**	(0.012)	-0.03**	(0.01)	-0.04**	(0.01)	-0.09**	(0.01)	-0.11**	(0.01)
Alliance size	0.04	(0.052)	0.051	(0.052)	0.01**	(0)	0.01**	(0)	0.01*	(0.00)	0.01**	(0.00)
First round VC status	0.077	(0.134)	0.109	(0.132)	-0.08	(0.23)	-0.07	(0.23)	-0.16	(0.23)	-0.07	(0.24)
Relative standing - VC investment size	0.309**	(0.033)	0.041	(0.108)								
Rel. standing-VC inv*VC			0.014*	(0.006)								
Rel. standing-VC inv* VC status			0.539*	(0.215)								
Relative standing – stage					0.21**	(0.05)	0.04	(0.1)				
Rel. standing-stage* VC size							0.02**	(0.01)				
Rel. standing-stage*VC status							0.45*	(0.23)				
Relative standing - alliances									0.61**	(0.03)	0.49**	(0.05)
Rel. standing-alnc*VC size											0.02**	(0.01)
Rel. standing -alnc* VC status											0.46*	(0.19)
Log pseudolikelihood	-1624		-1617		-1644		-1637		-1516		-1503	

** p<0.01, * p<0.05, + p<0.10. Robust standard errors are in parentheses. N=33,779