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Human capital theory and venture capital firms: Exploring “home runs” and “strike outs”

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Abstract

Using a human capital perspective, we investigated the relationship between the education and experience of the top management teams of venture capital firms and the firms' performance. We found that although general human capital had a positive association with the proportion of portfolio companies that went public (IPO), specific human capital did not. However, we did find that specific human capital was negatively associated with the proportion of portfolio companies that went bankrupt. Interestingly, some findings were contrary to expectations from a human capital perspective, specifically the relationship between general human capital and the proportion of portfolio companies that went bankrupt. Future research is suggested.

Keywords: Venture capital firms; Human capital; Initial Public Offering; Bankruptcy

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1. Executive Summary

Venture capitalists who can better assess and assist portfolio companies will have more successful exits from their portfolio companies and less portfolio companies that provide little or no return to the venture capital firm. Human capital theory posits that individuals with more or higher quality human capital achieve higher performance in executing relevant tasks, such as the pre- and post-investment activities of the venture capital process. In this article we investigate the relationship between the human capital and performance of venture capital firms (VCFs). Specifically, we explore the types of education and industry experiences represented by the top management teams of venture capital firms and then investigate their relationship with two dimensions of investment performance – "home runs," or portfolio companies that go public, and "strike outs," or portfolio companies that go bankrupt.

While there were no significant results for specific human capital in explaining "home runs," there were expected results for specific human capital in explaining "strike outs" and for general human capital in explaining "home runs." Specifically, our findings suggest that aspects of general human capital – education in science and humanities – have a positive association with the proportion of "home runs" in a VCF's portfolio. The results for "strike outs" show that VCFs with top management team with higher specific human capital – MBA, law education, and consulting experience – have lower proportions of bankruptcies in their portfolios. Surprisingly, we also found that law industry experience was positively associated with the proportion of bankruptcies in a VCF's portfolio. Another set of surprising findings concerned the relationship between general human capital and "strike outs:" VCFs with higher prevalence of science and humanities education among their top management team members had higher prevalence of bankruptcies in their portfolios.

This article makes a number of contributions. First, we use a more fine-grained approach to human capital by investigating the performance effects of different types of education and experience represented by a venture capital firm's top management team. Second, we acknowledge two dimensions of performance and investigate how types of human capital are differentially associated with these performance dimensions. Third, the venture capital and entrepreneurship literatures have focused on understanding the "home runs" (initial public offerings), but have relatively ignored the potential downside of performance outcomes. We add to this literature an investigation of portfolio company bankruptcies. Finally, we offer a number of important topics for future research.

In addition, the results of this study have some important implications for practitioners. Venture capital firms may build their investment teams with a human capital consideration in mind. Understanding the human capital factors contributing to achieving more "home runs" and less "strike outs" can help build teams that increase firm performance. But they must acknowledge that aspects of human capital differ in their impact on each performance dimension. Similarly, entrepreneurs seeking venture capital finance may increase their awareness of the value that a venture capital firm could bring to their start-up company. By pre-examining the backgrounds of the venture capital firms' top management teams, entrepreneurs can target those venture capital firms that could make the greatest contribution to their success.

2. Introduction

The belief that the decisions of top management teams impact firm outcomes is central to the literatures of strategy and management. Strategists who can accurately predict and adapt to changes in the external environment can better position their companies for success. Similarly, venture capitalists (VCs) who can better assess and assist portfolio companies will have more

successful exits from their portfolio companies and less portfolio companies that provide little or no return to the venture capital firm (VCF).

One way to capture the decision-making processes of top management teams is by using the demographic characteristics of the team members as a proxy (Hambrick and Mason, 1984). Two key demographic characteristics, education and experience, underlie the concept of human capital (Becker, 1975). A key component of human capital is the possession of knowledge that is specific and not easily appropriable, and which yields competitive advantage (Barney, 1991; Pennings, Lee, and Witteloostuijn, 1998; Wright, Smart, and McMahan, 1995). Numerous studies have established that human capital is a key factor in explaining organizational performance (Bruderl, Preisendorfer, and Ziegler, 1992; Gimeno, Folta, Cooper, and Woo, 1997; Pennings et al., 1998).

However, studies to date have focused on the quantitative nature of human capital, i.e., the idea that more is better, and have accordingly used measures such as years or degree of education (Bruderl et al., 1992; Cooper, Gimeno-Gascon, and Woo, 1994; Gimeno, Folta et al., 1997) or experience (Bruderl et al., 1992; Evans and Leighton, 1989). When it comes to understanding knowledge as a key resource of the firm, it is also important to consider the qualitative aspects of human capital. In contexts where firms possess large quantities of human capital, differences in quantity may matter less than differences in quality. By distinguishing between types of education and types of experiences we have the opportunity to better understand which aspects of human capital are associated with higher performance.

The venture capital context is particularly suited for studying the qualitative nature of human capital – venture capitalists possess knowledge and experience that is both extensive and diverse. In addition, this context offers a possibility to study multiple dimensions of

performance. VCFs' performance is enhanced when their portfolio companies go public ("home runs") and diminished when their portfolio companies go bankrupt ("strike outs"). Therefore, in this article we investigate the relationship between human capital – the types of education and industry experience represented by the VCFs' top management teams – and two dimensions of VCF investment performance, "home runs" and "strike outs."

In doing so, this article makes a number of contributions. First, we use a more fine-grained approach to human capital by investigating the performance effects of different types of education and experience represented by a venture capital firm's top management team. Second, we acknowledge two dimensions of performance and investigate how types of human capital are differentially associated with these performance dimensions. Third, the venture capital and entrepreneurship literatures have focused on understanding the "home runs" (initial public offerings), but have relatively ignored the potential downside of performance outcomes. We add to this literature an investigation of portfolio company bankruptcies. Finally, we offer a number of important topics for future research.

This article proceeds as follows. First, we discuss the tasks of venture capitalists and the two dimensions of performance. Second, we discuss the contribution of different aspects of human capital to the two types of performance and derive specific hypotheses. Third, we detail the research method used to test the hypotheses and present the results. Finally, we discuss the results and outline some implications for entrepreneurship scholars and practitioners.

3. Theory and hypotheses

3.1. The performance of venture capital firms

The performance of a VCF is typically measured by the rates of return of the funds it manages, which are in turn dependent on the ability of the VCF to sell its investment stakes to

third parties. An initial public offering (IPO) offers the entrepreneurial company a number of benefits, including legitimacy with stakeholders, access to debt capital (Sutton and Benedetto, 1988), and a mechanism by which entrepreneurs can reacquire control from investors (Black and Gilson, 1998). For investors, an IPO represents an attractive exit mechanism (Sutton and Benedetto, 1988), and contributes greatly to the upside potential of a fund's performance. Several studies have provided evidence in this regard. Bygrave and Timmons (1991) found that companies that went public within 34 months of the first round of financing had a higher time-adjusted rate of return than those that went public later (287% versus 158%).² As they note, "hot IPO markets are by far the most important cause of peaks in venture capital returns" (p. 159). Similarly, Sahlman (1990) documented that almost all of the returns on venture capital funds were earned on portfolio companies that went public.

While portfolio companies that go public boost fund returns, portfolio companies that fail push returns downwards. Reducing the number of portfolio companies that fail is a way to improve returns, albeit in a way that limits their downside rather than increases their upside. The factors that enhance profitability of a venture are likely different from those that improve its survival chances (Radner and Shepp, 1996). We also acknowledge this difference and thus set out to study both aspects of VCF performance – "home runs," or portfolio companies going public, and "strike outs," or portfolio companies going bankrupt.

In order to understand the factors behind having more "home runs" and less "strike outs," it is necessary to identify the nature of VC involvement in their portfolio companies. For the purpose of this article, the task of the VCF can be classified in terms of pre- and post-investment

² This advantage disappeared six quarters after the Initial Public Offering (IPO) date.

activities.³ Pre-investment activities involve those tasks up to, and including, the signing of an investment contract, e.g., soliciting new venture proposals for submission to the VC firm, determining whether these proposals meet the firm's broad screening criteria, conducting due diligence (more extensive research to determine the likely success of the venture), and then negotiating and structuring a relationship with the entrepreneur. Post-investment activities include all actions by the VC firm after the initial investment deal has been signed, e.g., finding and recruiting top quality management, finding other co-investors for immediate or follow up investment, introducing the venture to important service providers such as specialized accountants, and helping the venture find and develop necessary strategic alliances (Sandberg, 1986). Furthermore, VCs often serve as a sounding board for management ideas, and are a valuable source of strategic and operational advice (Lerner, 1994a; 1995; Sweeting, 1991).

In regard to pre-investment activities, there has been considerable interest in understanding the ability of VCs to select companies that are most likely to succeed and go public. Most of the research on VCs' decision-making has investigated how VCs assess the prospects of a portfolio company in terms of profitability (e.g., Roure and Keeley, 1990; Shepherd, Ettenson, and Crouch, 2000), survival (e.g., Shepherd, 1999), and performance in general (e.g., Khan, 1987; Zacharakis and Meyer, 2000; Zacharakis and Shepherd, in press). More generally, Tyebjee and Bruno (1984) argued that VCs' investment decisions could be predicted from their perceptions of risk and return. Similarly, we regard the post-investment involvement of VCs as related to perceiving and responding to opportunities and threats in order to increase the chances of success of the portfolio companies.

³ Tyebjee and Bruno (1984) proposed a model of the venture capital process with five stages: deal origination, deal screening, deal evaluation, deal structuring and post-investment.

3.2. Human capital and differences in performance

Having identified the perceptions of risk, return, opportunities, and threats as underlying venture capitalists' decisions and thus contributing to VCF performance, we now need to understand what makes these perceptions vary across VCFs. One key factor contributing to risk perception is problem domain familiarity – there is less perceived risk in familiar domains than in unfamiliar ones (Sitkin and Pablo, 1992). Similarly, in perceiving returns, VCs would be guided by their knowledge and understanding of the value that can be added and extracted from the portfolio company. In recognizing opportunities and threats, VCs are guided by their perception of looming gains or losses, by their feeling of having discretion over the situation at hand, and by whether they possess key resources (Jackson and Dutton, 1988). What these brief arguments suggest is that a key ingredient to having accurate perceptions of risk, return, opportunities, and threats is having relevant knowledge.

Further, as VCF investments are often in emerging industries, the above perceptions are also influenced by the ability to accumulate new knowledge, which is in turn dependent upon the existing stock of knowledge (Cohen and Levinthal, 1990). This stock of knowledge includes both explicit knowledge, formally acquired in educational institutions, and implicit knowledge acquired during one's experience in a particular domain. As these aspects of knowledge underlie the concept of human capital, we will elaborate in more detail on the contribution of human capital to a VCF's "home runs" and "strike outs."

The link between organizational human capital and performance can be understood in the context of the resource-based view of the firm, which associates superior performance with the possession of resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). Knowledge is a resource that readily meets these conditions, is heterogeneously distributed

across firms, and is thus central to understanding differences in performance (Spender, 1996). Not all knowledge, however, renders a firm unique – it is its tacit component, embedded in the firm’s social context, that makes the yielded advantage long lasting (Spender, 1996).

Although all knowledge has an explicit component, personal knowledge is often tacit in nature, reflecting a person’s unique social environment and past experience (Polanyi, 1967). While explicit knowledge can be articulated, codified and more easily transmitted across people and organizations, tacit knowledge tends to ‘stick’ to particular individuals or firms in ways that make their actions and decisions difficult to replicate. Human capital represents the knowledge and skills that individuals bring to an organization. As it is developed through both education and personal experience, it contributes to both the explicit and tacit knowledge of the firm.

The contribution to tacit knowledge is particularly strong in the venture capital context, as VCFs typically consist of a small number of people (the partners of the firm) with great deal making and value adding skills. These people have typically entered the venture capital industry after extensive experience in other industries (Bygrave and Timmons, 1992). The nature of their tacit knowledge may be distinguished less by the amount of human capital they have than by the domain components of their human capital. Although the basic tenet of human capital theory is that the greater the human capital the better the performance at a particular task (Becker, 1975), the nature of this proposition changes at the firm level and in the context of firms with significant amounts of human capital. Specifically, as it is the collective (organizational) tacit knowledge that makes the organization distinct (Spender, 1996), we need to examine the extent to which individual tacit knowledge is developed into a collective one. Key to this process of collectivization of knowledge is the sustained interaction among the individuals in the firm (Nonaka, 1994) in the context of a particular organizational activity (Spender, 1996). Thus,

because individual venture capitalists enter the firm with knowledge and experience from multiple domains, the extent to which their knowledge and experience in particular domains would contribute to the firm's tacit knowledge will be dependent on the extent to which other members of the firm also have experience in that domain. It is the shared knowledge and experience of several VCF partners that make for a distinct firm-level tacit knowledge in regard to their pre- and post-investment activities. Therefore, in order to understand the nature of a VCF's tacit knowledge it is essential that we examine the domain components of their human capital rather than just their total human capital.

In assessing the contributions of the various domain components of human capital to the performance of the VCF, it is useful to distinguish between general and specific human capital in regard to the domains of pre- and post-investment activities identified above. General human capital refers to overall education and practical experience, while specific human capital refers to education and experience with a scope of application limited to a particular activity or context (Becker, 1975; Gimeno, Cooper et al., 1997).⁴ We distinguish between general and specific human capital on the basis of whether education and experience in a particular domain provide skills that are directly used in carrying out the activities of investment selection and management. While all education may make some contribution to general human capital, some of it contributes more to specific human capital than to general human capital. Education and experience specific to the pre- and post-investment activities of venture capitalists include business, law, and consulting. Business education and experience provide expertise in screening

⁴ In order to dissipate any confusion that may arise in regard to the usage of general and specific human capital in the following analysis, we acknowledge that there have been different ways in which general and specific human capital have been distinguished in particular contexts. For example, Pennings et al. (1998), studying audit firms, equate general human capital with industry-specific education and experience, and specific human capital with firm-specific experience. Alternatively, Gimeno, Cooper et al. (1997), studying entrepreneurial firms across various industries, equate general human capital with overall education and experience, and specific human capital with education and experience in the particular industry of the venture.

potential portfolio companies, in conducting the more detailed assessment required as part of due diligence, and in advising the portfolio company's management team on operational and strategic issues. Experience in finance is particularly relevant in structuring the investment deal. Education and experience in law provides expertise in investment contracts, in aspects of due diligence, and in exiting from the portfolio companies (i.e., IPO or bankruptcy). Consulting experience provides expertise in detecting problems with a portfolio company and in communicating advice to its top management team.

Education that is not directly related to the tasks of the VCF can be considered more general in its contribution to human capital. For example, education in humanities is designed to be broad in its application. In addition, education in science, although more specialized, is not directly related to the pre- and post-investment activities of a VCF. Therefore, we may regard these types of education as contributing to general human capital. Experience running an entrepreneurial firm provides considerable expertise but not necessarily directly related to the more formal and bureaucratic activities required of a VC.⁵ For this reason, entrepreneurial experience likely contributes more to general rather than specific human capital. Based on the performance proposition outlined above, we offer the following:

Hypothesis 1: VCFs with greater proportions of their top management teams with specific human capital in terms of education (a) at masters' level in business (MBA) and (b) in law, as well as industry experience in (c) law, (d) finance, and (e) consulting, will have higher proportions of "home runs" in their portfolios.

Hypothesis 2: VCFs with greater proportions of their top management teams with specific human capital in terms of education (a) at masters' level in business (MBA), and (b) in law,

⁵ Although some entrepreneurs may have raised venture capital numerous times and therefore gained some specific insight into undertaking pre- and post-investment activities.

as well as industry experience in (c) law, (d) finance, and (e) consulting, will have lower proportions of "strike outs" in their portfolios.

Hypothesis 3: VCFs with greater proportions of their top management teams with general human capital in terms of education in (a) humanities, and (b) science as well as (c) entrepreneurial experience will have higher proportions of "home runs" in their portfolios.

Hypothesis 4: VCFs with greater proportions of their top management teams with general human capital in terms of education in (a) humanities, and (b) science as well as (c) entrepreneurial experience will have lower proportions of "strike outs" in their portfolios.

As these hypotheses refer to only positive effects of human capital on performance they may appear inconsistent with arguments about an "U-shaped" relationship between human capital and performance, particularly firm survival (Bruderl et al., 1992; Pennings et al., 1998). This relationship is usually explained by the effect of ageing. While this effect may be relevant in the context of conceptualizing human capital as the number of years of experience, it holds no concrete implications for the more detailed, qualitative nature of human capital that we explore.⁶

3.3. Exploring an alternative perspective

Although much of the research on human capital theory has operationalized general human capital in terms of years of schooling, the empirical support for a positive relationship between education and performance at a particular task is mixed. For example, while there is a positive relationship between education and productivity (Jones, 2001; Corvers, 1997) and education and survival (Pennings et al., 1998), there is no clear effect of education on other indicators of performance, namely career progress (Wayne, Liden, Kraimer, and Graf, 1999) and job attainment (Dolton and Vignoles, 2000). Similarly, in the entrepreneurship literature, the

findings for a positive association between education and business start-ups (Bates, 1990; Evans and Leighton, 1989), and between education and the discovery and exploitation of opportunities (Davidsson and Honig, 2003) have been mixed. A possible explanation for this is that broad-brush measures have insufficient sensitivity for the different impact that general and specific human capital can have on performance, especially when considering different dimensions of performance.

We propose that the type of human capital required to maximize “home runs” does not necessarily minimize “strike outs” and vice versa. For example, experience and education in business and law are specific to the task required of a VC. This specific human capital provides the VCF with the ability to critically analyze business plans, find holes in business models, negotiate venture capital contracts, and implement some risk reduction strategies. Thus, these specific human capital factors essentially facilitate the prevention of “strike outs.” Those with human capital that is more general, such as education in humanities, are likely less focused on and less trained in detecting specific risks. General human capital does, however, provide benefits to firms. It facilitates the integration and accumulation of new knowledge, which provides individuals with larger opportunity sets (cf. Gimeno, Cooper et al., 1997) and assists them in adapting to new situations. Therefore, it is possible that those with more general human capital focus more on the opportunities than the risks associated with potential deals, i.e., on scoring "home runs" rather than on avoiding "strike outs."

Although the above arguments appear reasonable, there is little human capital theory upon which to hypothesize the nature of this finer-grained distinction between types of education and experiences and dimensions of performance. The following, therefore, are exploratory

⁶ We do test for the possibility of curvilinear relationships between the human capital variables and both measures of performance.

propositions and offer an alternative perspective to that offered by human capital theory as represented in hypotheses 1-4 above.

Alternative Proposition 1: The educational specialties of VCFs' top management teams will have different relationships with the proportions of "home runs" and "strike outs" in their portfolios.

Alternative Proposition 2: The types of industry experience of a VCFs' top management teams will have different relationships with the proportions of "home runs" and "strike outs" in their portfolios.

4. Research method

4.1. Research design and sample

Two factors were instrumental in designing the study. We needed a sample of VCFs that had made a sufficient number of investments in portfolio companies, had sufficient time for those investments to have reached an outcome – gone public or gone bankrupt – and had invested in similar industries, to alleviate possible confounding effects. Therefore, from the *VentureXpert* database, we drew a list of all independent VCFs in the US that had invested in at least 20 portfolio companies – 555 firms in total. From these, we then randomly selected and obtained information on 112 VCFs that have also made at least one investment in the Wireless Communication industry, as defined in the *VentureXpert* database. Out of the 555 firms with at least 20 portfolio companies, 303 had also made at least one investment in this industry. It must be noted that given the focus of this research and the sample selected, our results may not be highly generalizable to those VCFs that are small, young, or from outside the US. Even though a large portion of all VCFs have invested in the Wireless Communication industry, care must also be taken in generalizing our findings to VCFs that have made no investments in this industry.

4.2. Measures

4.2.1. Dependent variables

We investigated two dependent variables: "home runs," operationalized as the proportion of companies added to the VCF's portfolio in the last five years that had gone public, and "strike outs," operationalized as the proportion of the same companies that had gone bankrupt. We obtained information on the status of each portfolio company as of September 2002 from the *VentureXpert* database. We regarded a company as public if its status was listed as "went public" or "in registration" and as bankrupt if its status was listed as "bankrupt – chapter 11," "defunct," and "bankrupt – chapter 7."

We gathered the data on the human capital of the VCFs' top management teams from the VCFs' websites. These websites typically contained sections named "team," "investment team," or "who we are," which detailed the biographies of the top management team members. Our operational definition of top management team was all people holding the title "general partner" or, in the absence of such a title, the highest ranking title in the firm hierarchy. Among the alternative titles used were "partners," "managing directors," "directors," and "principals." We collected data on a total of 749 top management team members, or an average of 6.7 per VCF.

4.2.2. Education

The biographical sketch of each partner typically contained information on the formal education that the partner had obtained. We used this information to measure our education-related human capital variables. We coded each top management team member for whether he or she had attained any of the following education degrees or classes of degrees: MBA, Law (JD), Science, and Humanities. *Science* reflected all bachelors and masters degrees in mathematics, natural sciences, and engineering. *Humanities* reflected all degrees in art or social sciences

(excluding economics). We calculated a score for each of these degrees to represent the proportion of top management team members that had attained this type of education. Thus, if two out of a total of five partners had *science* degrees, the score for *science* education would be 0.4. Unlike measures based on determining one dominant specialization for each top management team member or for the top management team as a whole (e.g., Wiersema and Bantel, 1992), this measure captures the prevalence of particular educational specializations as it allows for more than one degree to be recorded per individual.

4.2.3. *Industry experience*

The biographical sketch of each partner also contained information on the industries and positions in which the partner had worked prior to joining the VCF. We used this information to measure our industry-related human capital variables. We coded each top management team member for whether he or she had worked in the following industries – finance, consulting, and law – and for whether he or she had had any entrepreneurial experience. *Finance industry experience* included commercial, investment, and merchant banking as well as investment fund management, in both public and private markets. *Consulting industry experience* reflected whether a partner had worked for a company designated as providing consulting services. *Law industry experience* reflected whether a partner had worked for a law firm. Finally, *entrepreneurial experience* reflected whether a partner had previously been founder of a company. We obtained a score for each type of industry experience based on the proportion of top management team members that had had such experience. For example, a score of 0.35 for *finance industry experience* would indicate that 35% of the TMT members had worked in the finance-related industries listed above.

4.2.4. *Control variables*

We used three control variables, all of them measured with data from the *VentureXpert* database. *VCF age* was calculated as the number of years from founding to the end of 2001. In cases where the founding year was missing, both in the database and on the company website, we took the year in which the firm made its first investment as a proxy for founding year. *VCF size* was measured as the total invested capital (thousands of US dollars). *VCF stage specialization* was measured as a dichotomous variable: 1 if more than 50% of the firm's first-time investments over the studied five-year period were made in portfolio companies in start-up, seed or other early stages, and 0 otherwise.

5. Analyses and results

The correlations and descriptive statistics for the variables are presented in Table 1. Our collinearity diagnostics showed that all variance inflation factor values were below 3.0, suggesting that multicollinearity was not an issue (cf. Hair, Anderson, Tatham, and Black, 1998). We used hierarchical regression analysis to test hypotheses one through four and canonical correlation analysis to explore the alternative propositions.

5.1. Hierarchical regression analysis and results

We conducted several diagnostic tests to ensure the data did not violate the assumptions of normality, linearity, and homoscedasticity necessary for OLS regression estimation. Using Z scores and a visual inspection of histograms we found all variables to be normally distributed, although the dependent variable for “home runs” had five outliers. These outliers did not suggest the need for transformation and were therefore not used in subsequent analyses. Residual plots indicated a linear relationship between independent variables and dependent variables. To especially guard against possible curvilinear relationships we plotted each independent-dependent variable relationship and conducted one-way ANOVA to test for this relationship –

there were no significant curvilinear relationships ($p > .05$). Finally, a plot of the standardized residuals and the standardized predicted values indicated that residuals were randomly scattered, suggesting no violation of the constant variance assumption.

The results of the hierarchical regression analysis for both “home runs” and “strike outs” are reported in Table 2. To analyze “home runs,” we first entered the control variables of VCF age, size, and stage specialization. This base model was statistically significant ($R^2 = .36$, $p < .01$). The addition of the predictor variables made a significant contribution over and above the base model ($\Delta R^2 = .12$, $p < .05$). In the full model, there were significant coefficients for education in science ($B = .08$, $p < .01$) and in humanities ($B = .05$, $p < .05$), and a marginally significant coefficient for consulting industry experience ($B = -.05$, $p < .10$). VCFs with higher proportions of top management team members with education in science and in humanities have higher proportions of “home runs” in their portfolios. These results support hypotheses 3a and 3b respectively. Conversely, VCFs with higher prevalence of consulting industry experience have lower proportions of “home runs.” This relationship is in the opposite direction to that proposed in hypothesis 1e. The effects for the remaining types of education and industry experience were not significant and therefore hypotheses 1a-d, and 3c were not supported.

Insert Tables 1 and 2 about here

In the results for “strike outs,” the base model was not statistically significant ($R^2 = .05$, $p > .10$). The addition of the predictor variables made a significant contribution over and above the base model ($\Delta R^2 = .22$, $p < .01$). In the full model, there were significant coefficients for MBA ($B = -.05$, $p < .01$) and law education ($B = -.12$, $p < .01$). The negative values of these coefficients indicate that VCFs with higher proportions of top management team members with

MBA or law education have lower proportions of bankruptcies in their portfolios. These results provide support for hypotheses 2a and 2b.

There were also significant coefficients for industry experience in law ($B = .15, p < .05$) and consulting ($B = -.08, p < .01$). The positive coefficient for industry experience in law indicates that VCFs with greater prevalence of such experience have higher proportions of bankruptcies in their portfolios, a result in the opposite direction to that proposed by hypothesis 2c. The negative coefficient for consulting experience indicates that VCFs with greater prevalence of such experience have lower proportions of bankruptcies in their portfolios, a result supporting hypothesis 2e. The effect for finance industry experience was not significant and therefore hypothesis 2d is not supported.

The full model for "strike outs" also contained significant coefficients for education in science ($B = .04, p < .05$) and in humanities ($B = .05, p < .01$), and a marginally significant coefficient for entrepreneurial experience ($B = -.04, p < .10$). The positive values of the education coefficients indicate that where a higher proportion of partners had had such education VCFs have a higher proportion of bankruptcies in their portfolio. These findings are in the opposite direction to that proposed in hypotheses 4a and 4b. The negative coefficient for entrepreneurial experience provides marginal support for hypothesis 4c.

5.2. Canonical correlation analysis and results

In the above analyses we regarded the two performance measures, "home runs" and "strike outs," as independent. Yet, because these measures pertain to the same venture capital firms and are linked to the same human capital variables, they are not necessarily independent of one another and should be considered simultaneously. In doing so, we used canonical correlation analysis, a method well suited for studies with multiple dependent and independent variables.

Similar to regression estimation, canonical correlation derives loadings for the independent variables, but unlike regression analysis it also derives a set of loadings for the dependent variables⁷. These canonical loadings are derived so as to maximize the correlation between the linear combination of “home runs” and “strike outs” and the linear combination of the independent variables. This correlation between the two linear combinations is referred to as the canonical correlation. An eigenvalue (or canonical root) is the square of the canonical correlation and represents the amount of explained variance in one set of variables (the human capital variables) that is accounted for by the other set of variables (“home runs” and “strike outs”). The canonical correlation analysis generates (at least) two canonical functions, each with a canonical correlation and canonical loadings. The first is derived to maximize the intercorrelation between the two sets of variables. The second function maximizes the intercorrelation between the two sets of variables not captured by the first function. We coded “strike outs” with a negative sign so that the higher its value the fewer the strike outs.

Insert Tables 3 about here

The results of the canonical analysis are reported in Table 3. Both functions are significant ($p < .01$), which means that the variate for “home runs” and “strike outs” and the variate for human capital explain a significant portion of variance in each other. But when we investigate the loadings for the dependent variables, “home runs” dominate for function one and “strike outs” dominate for function two (loadings less the .30 are typically not considered in the analysis). This suggests that the human capital variables useful in explaining “home runs” are

⁷ Canonical weights are also reported. Although canonical weights provide an indication of the nature of the relationship between canonical variables, canonical loadings provide a more rigorous means of interpreting the relationship (Hair, Anderson et al., 1998).

not particularly useful in explaining “strike outs” and vice versa. With this pattern of relationships, the simultaneous consideration of the human capital variables with a linear combination of “home runs” and “strike outs” appears to add little value over and above their independent consideration.

6. Discussion

In a broad sense, our findings suggest that human capital provides a significant explanation of variations in the examined dimensions of performance, over the effects accounted for by firm characteristics. We have shown that for particular knowledge areas, the higher the overlap among the partners the higher the performance of the VCF. This provides support to the notion that "top management matters" and to the presented conceptual argument that firm knowledge developed in particular areas yields competitive advantage. However, since not all knowledge areas had significant or positive effects, we need to subject the relationships between the particular knowledge areas examined and the two dimensions of performance to a closer analytical scrutiny.

6.1. Specific human capital and “strike outs”

As expected, we found that those VCFs with greater proportions of their top management teams with MBA, law education, and consulting experience had lower proportions of bankruptcies in their portfolios. This is consistent with findings suggesting a positive link between specific human capital and venture survival (Gimeno, Cooper et al., 1997). This is also consistent with the findings of Pennings et al. (1998) that industry-specific human capital is negatively related to firm dissolution. Although these authors regard industry-specific experience as general human capital, this different classification is largely due to their studying a single, more homogeneous industry.

Interestingly, we found that those VCFs with greater proportions of their top management teams with law experience had higher proportions of bankruptcies in their portfolios. This result was surprising at first because it appeared inconsistent with human capital theory, but upon further reflection it might offer an interesting insight into the post-deal management of portfolio companies. For companies that are not performing well and have the prospect of further deteriorating performance, declaring bankruptcy for the company is possibly the only way for VCFs to get something back from such company. In this regard, law experience both gives expertise into the practicalities of bankruptcy proceedings and instils attitudes for pushing for bankruptcies. This finding is particularly interesting given the opposite effect that law education has. It might be that law education can help VCFs enter into and structure relationships with well-performing portfolio companies, whereas experience in law helps the VCFs withdraw from those relationships that turn unproductive. These possible explanations are speculation on our part and require further research to investigate the relationship between the role of law-related human capital and “strike outs.”

6.2. *General human capital and “home runs”*

As expected, we found that those VCFs with greater proportions of their top management teams with education in humanities and in science had higher proportions of “home runs” in their portfolios. This is broadly consistent with the findings of a positive relationship between education as a proxy for general human capital and various aspects of performance, namely firm growth (Cooper et al., 1994) and opportunity discovery (Davidsson and Honig, 2003). In regard to why the particular educational specializations of *science* and *humanities* have a positive association with “home runs,” the current findings are also consistent with the notion of general human capital facilitating access to a wider opportunity set (Gimeno, Cooper et al., 1997).

Perhaps the firm knowledge built around the shared education in these areas enables the VCF to successfully respond to and integrate new technological advances, and to successfully anticipate the market acceptance of the commercial products based on such technological advances.

6.3. General human capital and “strike outs”

Of the tests of the three hypotheses on general human capital and “strike outs,” two were significant in the opposite direction to that hypothesized and the third was only marginally significant (in the hypothesized direction). We found that those VCFs with greater proportions of their top management teams with education in humanities and in science had higher proportions of “strike outs” in their portfolios. At a first glance, this contradicts established findings that education, as a proxy for general human capital, is positively related to survival (Bruderl et al., 1992; Cooper et al., 1994; Gimeno, Cooper et al., 1997; Pennings et al., 1998). It is important to note, however, that because of the way education has been measured, these previous findings essentially refer to a comparison of more education to less education. Thus, our findings pertain to something that has not been previously explored, namely comparing the contribution of various educational specializations.

We speculate that the larger opportunity set that general human capital affords is of little material consequence for a firm with deteriorating performance and thus facing the prospect of going out of business. In fact, seeking new opportunities for a declining business may prove detrimental in that it takes attention away from streamlining and increasing the efficiency of the existing operations. Thus, when hands-on skills are called for in a critical situation, general human capital provides none. Given the speculative nature of this argument, future research that focuses on the differences in skills required for ensuring success versus avoiding failure will make a substantial contribution to the literature.

6.4. Human capital and both “home runs” and “strike outs”

Our canonical correlation analysis suggests that although the human capital variables we employ explain variations in both “home runs” and “strike outs,” there is little joint explanation of these two performance variables. In other words, the human capital variables explaining “home runs” are different from those explaining “strike outs,” and vice versa. These findings support our alternative hypotheses and deserve further elaboration since, as we stated in the theoretical section, current human capital theory is not sufficiently fine-grained to help us explain the findings.

We have shown that general human capital is positively associated with “home runs,” while specific human capital is positively associated with “strike outs.” What are the distinct aspects of these two elements of performance that interact with human capital? It is possible that there are two distinct approaches to ensuring successful performance. In a study contrasting bankers’ and entrepreneurs’ approaches towards risky ventures, Sarasvarthy, Simon, and Lave (1998) found that bankers sought to minimize risk while entrepreneurs sought to maximize success. The general idea of approaching positive outcomes and avoiding negative outcomes as motivational factors underpinning decision making has been well developed at the individual level (see Crowe and Higgins, 1997). Perhaps, in an organizational context, pursuing opportunities versus avoiding threats necessitates particular information processing approaches among the top decision makers. These approaches may in turn be associated with particular types of human capital, having been developed in previous educational or occupational contexts. Alternatively, these information processing approaches may be fortified or hindered by the possession (or lack thereof) of knowledge specific to the task at hand. In this regard, any future

research that links human capital with motivational or information processing aspects of achieving high performance stands to make a significant contribution to the literature.

6.5. Potential limitations and future research

This study, as all studies, has a number of limitations and possibilities for future research. First, we captured aspects of VCFs' human capital by measuring the education and experience of its management team to explain firm level outcomes. Although the top management team makes important strategic decisions for a firm (Hambrick and Mason, 1984; Wiersema and Bantel, 1992), capturing the human capital of all individuals within the organization might explain greater variance in VCF performance. However, such an approach does introduce a number of new challenges. It is likely difficult for researchers to access biographical information on all employees that work in VCFs. Further, how should the human capital of all these individuals be combined to provide an organizational level variable? A simple proportion of education and experience (as used in this study) does not take into sufficient consideration the different roles and responsibilities of those individuals. For example, a VCF might have more administrative staff such as receptionists and data entry personnel, that add to the general efficiency of the firm but who have little to do with the pre- and post-investment activities of the venture capital process. In this case, a proportion measure across the whole firm would appear to understate the human capital of the firm to maximize "home runs" and minimize "strike outs."

Second, the present study did not control for the quality or size of a VCF's deal flow. The attributes of the deal-flow could influence the proportions of "home runs" and "strike outs" in the portfolio. While this is a limitation of the study, it reflects the need for a more focused approach. To increase the size and quality of a VCF's deal flow is a pre-investment activity and based on the human capital literature discussed above, we would expect that those with more

human capital (or a type of human capital) would be able to generate a better deal flow, which is then reflected in superior performance. This limitation does highlight the need for future research to offer fine-grained analysis of the pre- and post-investment activities and more closely match types of human capital to these tasks. For example, one type of education might be beneficial at a pre-investment task but be of little benefit (or even detrimental) to the performance of a different, post-investment task.

Third, the present study did not control for the VCFs' possible syndication of the deals in which they have invested. A significant proportion of venture capital deals are syndicated (Bygrave, 1987; Lerner, 1994b) and the connectedness of VCFs within certain regions or industry sectors ranges between 22% and 69% (Bygrave 1988). Accounting for the co-investment partners of a VCF could either enhance or weaken the human capital effects reported in this paper because the base for human capital influence may expand or shift. This limitation also points to an important area for future research, namely, consideration of the human capital of syndicate partners when trying to gain a deeper understanding of VCF outcomes.

Fourth, although canonical correlation analysis is based on well established statistical methods of regression and factor analysis, and provides a highly useful and powerful technique for analysing sets of multiple dependent and independent variables (Hair, Anderson et al., 1998), its limitations must be noted. With canonical correlation analysis it is difficult to identify meaningful relationships between the two sets of variables because precise statistics have not yet been developed to interpret canonical analysis and we must rely on less adequate measures such as loadings (cf. Hair, Anderson et al., 1998). Despite the limitations of canonical analysis, when used in conjunction with well-established techniques (such as hierarchical regression) and used

for the purpose of exploring the nature of the simultaneous affect of one set of variables on another set of variables, it can provide considerable insight, as we have demonstrated.

Finally, there are limitations to the generalizability of our results. As our sample excludes those VCFs that have not invested in the Wireless Communication industry, our results may not be generalizable beyond the context of the sample. For those that do wish to relate the findings to the broader population of VCF firms, there can be comfort in the fact that, within the group of larger VCFs (those with at least 20 portfolio companies), there are no significant differences between investors versus non-investors in the Wireless Communication industry in terms of founding date (1986 vs. 1986) and state location (Chi-square = 8.38, 10 d.f., $p > .59$). The investors in Wireless Communication, however, tend to be larger in terms of both number of portfolio companies (101 vs. 75) and total invested capital (\$730 million vs. \$488 million). Essentially, our sample includes half of the top 100 VCFs and 40 percent of the top 200 VCFs. Thus, on one hand, our findings may be more applicable to the set of larger VCFs. On the other hand, although the Wireless Communication industry shares many similarities with other high-tech industries, care must be taken in generalizing our findings to VCFs focusing on other high-tech industries, on medium- or low-tech industries, or on Wireless industries in other countries. It could be that types of education beneficial in conducting pre- and post-investment activities with high-tech portfolio companies might be less beneficial or even detrimental in conducting these activities with low-tech portfolio companies. Detecting and explaining such industry sector or country differences would likely make an important contribution to the literature.

7. Conclusion

The general implication of human capital theory is that more is better. Empirical support for this claim has been predominantly based on using years of education or experience as proxy

for human capital. From a methodological point of view, the empirical studies in this stream essentially compare contexts where human capital abounds to contexts where it is lacking. There is thus less theoretical and empirical precision in contexts where there are no apparent or sizeable differences in the ‘amount’ of human capital. The current paper explores the qualitative nature of human capital by examining the specific domains of which it is composed. We show that particular aspects of human capital contribute to some but not all dimensions of performance. Understanding the qualitative nature of human capital, as well as its links to the various facets of performance, makes an important extension of the theory.

In addition, the results of this study have some important implications for practitioners. Venture capital firms may build their investment teams with a human capital consideration in mind. Understanding the human capital factors contributing to achieving more “home runs” and less “strike outs” can help build teams that increase firm performance. But they must acknowledge that aspects of human capital differ in their impact on each performance dimension. Similarly, entrepreneurs seeking venture capital finance may increase their awareness of the value that a venture capital firm could bring to their start-up company. By pre-examining the backgrounds of the venture capital firm’s top management team, entrepreneurs can target those venture capital firms that could make the greatest contribution to their success.

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Table 1Descriptive Statistics and Correlations^a

	<i>Mean</i>	<i>s.d.</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>
1. Education MBA	.5754	.2815	1.000											
2. Education in Science	.4753	.2791	.284	1.000										
3. Education in Humanities	.1970	.2293	-.029	-.421	1.000									
4. Education in Law	.076	.1304	-.296	-.264	.276	1.000								
5. Industry exp- Law	.050	.1002	-.319	-.254	.306	.762	1.000							
6. Industry exp- Finance	.5786	.3212	.277	-.316	.030	-.040	-.136	1.000						
7. Entrepreneurial exp	.1807	.1995	-.242	.274	-.059	.004	.183	-.411	1.000					
8. Industry exp- Consulting	.1482	.1847	.167	-.010	.084	.024	-.042	-.085	-.029	1.000				
9. Total Capital Invested ^b	866	1024	.154	.165	.036	-.049	-.119	-.072	-.043	.036	1.000			
10. Age of VCF	17.23	10.03	-.042	.060	-.037	-.142	-.125	-.297	-.085	-.084	.220	1.000		
11. Preferred Stage	.46	.50	-.032	.227	-.131	.033	.121	-.392	.296	.035	-.025	.047	1.000	
12. Portion gone public	.1025	.076	.039	.050	.080	-.065	-.003	.147	-.096	-.152	.305	-.036	-.418	1.000
13. Portion gone bankrupt	.058	.044	-.100	.031	.197	.027	.150	-.047	.002	.285	.046	-.171	.111	-.039

^an=112; All correlations with absolute value above 0.20 are significant at $p < .05$.^b indicates millions of US dollars.

Table 2Hierarchical Regression Analysis for “Home Runs” and “Strike Outs”^a

	“Home Runs”		“Strike Outs”	
	<i>Base model</i>	<i>Full Model</i>	<i>Base model</i>	<i>Full Model</i>
<i>Specific Human Capital</i>				
MBA education		-.010		-.049***
Law education		-.072		-.122***
Law experience		.086		.154**
Finance experience		.006		-.15
Consulting experience		-.045*		-.076***
<i>General Human Capital</i>				
Science education		.076***		.044**
Humanities education		.054**		.051***
Entrepreneurial experience		-.022		-.044*
<i>VCF Controls</i>				
Size ^b	.003***	.002***	.0004	.0004
Age	-.001	-.001	-.001**	-.001*
Stage specialization	-.050***	-.064***	-.011	-.012
Constant	.122***	.090***	.065	.051**
<i>Model</i>				
F Statistic	19.345	7.854	1.953	3.418
R ²	.360***	.476***	.051	.272***
Adjusted R ²	.342***	.416***	.025	.193***
ΔR^2	.360***	.116**	.051	.222***
N	107	107	112	112

^a Standardised regression coefficients are displayed in the Table.^b reported in millions of US dollars invested.

* p< 0.10; ** p< 0.05; *** p< 0.01.

Table 3

Canonical Correlation Analysis: Types of Human Capital on “Strike Outs” and “Home Runs”^a

	<i>Function 1 Loadings^b</i>	<i>Function 2 Loadings^b</i>
<i>VCF Controls</i>		
Size	.590	-.049
Age	-.285	.312
Stage specialization	-.620	-.424
<i>Specific Human Capital</i>		
MBA education	-.146	.561
Law education	-.314	.636
Law experience	.291	-.626
Finance experience	-.016	-.217
Consulting experience	-.115	-.626
<i>General Human Capital</i>		
Science education	.565	-.441
Humanities education	.362	-.457
Entrepreneurial experience	-.161	.393
<i>Dependent Variables</i>		
“Home runs”	.981	.180
“Strike outs”	-.197	.980
<i>Model</i>		
Eigenvalue	.935	.365
Squared Canonical Correlation	.483	.268
F Statistic for Wilks’ Lambda	5.345***	3.471***

^a n=107

^b Standardized canonical correlations.

*** $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.**